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NATIONAL DAM INSPECTION PROGRAM. GLEN BROOK NUMBER 4 DAM (NDI N--ETC(U)
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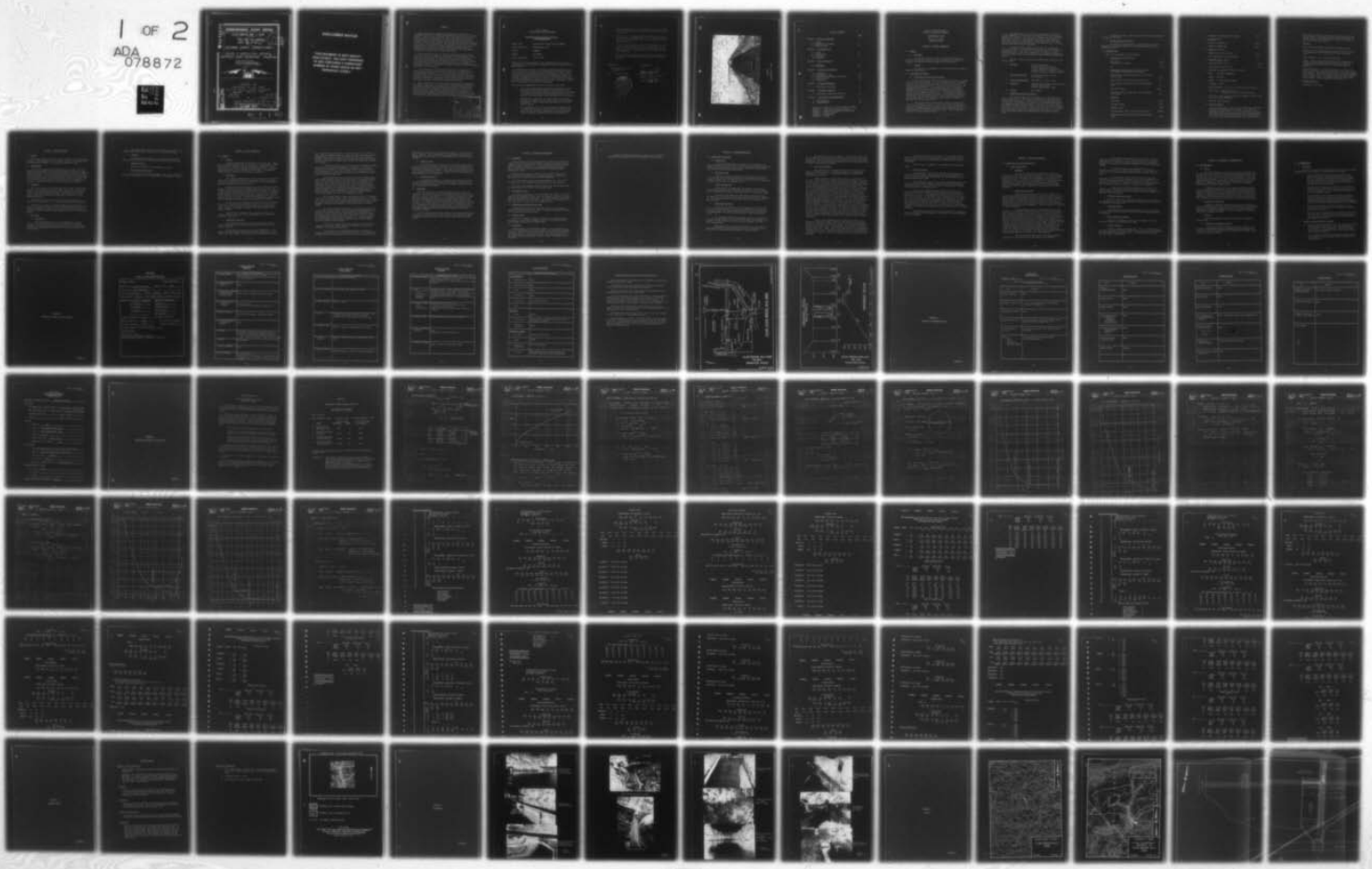

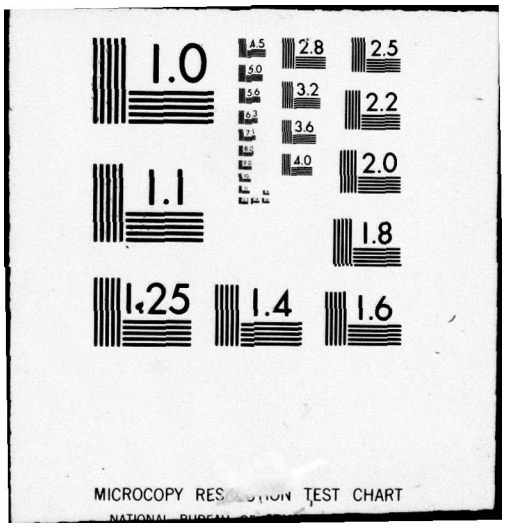
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National Dam Inspection Program.

GLEN BROOK NO. 4 DAM

Number

NDI NO. PA-00650

DER NO. 19-8

Number

LEVEL II

COLUMBIA COUNTY, PENNSYLVANIA.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

AUGUST 1979

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS AND RECOMMENDATIONS

Name of Dam:	Glen Brook No.4 Dam, NDI NO. PA-00650
State and State No:	PENNSYLVANIA, 19-8
County:	COLUMBIA
Stream:	GLEN BROOK
Date of Inspection:	June 20, 1979

[contd from page 1]

Based upon the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in fair condition.

In accordance with the Corps of Engineers' evaluation guidelines, the size classification of this dam is intermediate and the hazard classification is high. The spillway capacity is inadequate to pass the PMF (Probable Maximum Flood) peak inflow without overtopping the dam. The spillway is capable of passing 10 percent of the PMF and is classified as seriously inadequate. Failure of this dam will significantly increase the hazard to loss of life downstream from the dam. The project, therefore, is considered to be unsafe, non-emergency.

The following recommendations are made for action by the owner:

1. That a detailed hydrologic and hydraulic engineering analysis be made by a professional engineer with experience in the design and construction of dams to determine means for improving the capacity of the spillway and reservoir system so that it will meet the requirements of the Commonwealth of Pennsylvania.

2. That the valve controls in the intake tower be greased and operated on an annual basis to assure their use in the case of an emergency. This is especially applicable to the 20-inch blowoff control.

3. That maintenance of the flagstone forming the spillway crest be continued to provide a smooth entrance into the spillway chute and that the slight projections on the spillway chute walls be smoothed to provide better flow characteristics.

4. That the bridge decks across the spillway and to the intake tower be repaired and that a handrail be placed on the bridge to the tower.

5. That the source of seepage from the weepholes on the spillway chute slab be identified and that the cavity beneath the chute slab at the location of the lowest weephole be investigated and repaired.

6. That the regular maintenance of the dam embankment continue and that annual inspections be made and reported as to the findings of these inspections. Inspection items to include seepage, embankment slope condition and spillway crest and wall conditions.

7. That a formal surveillance and downstream warning system be developed to be used during periods of heavy or prolonged rainfall.

SUBMITTED BY:

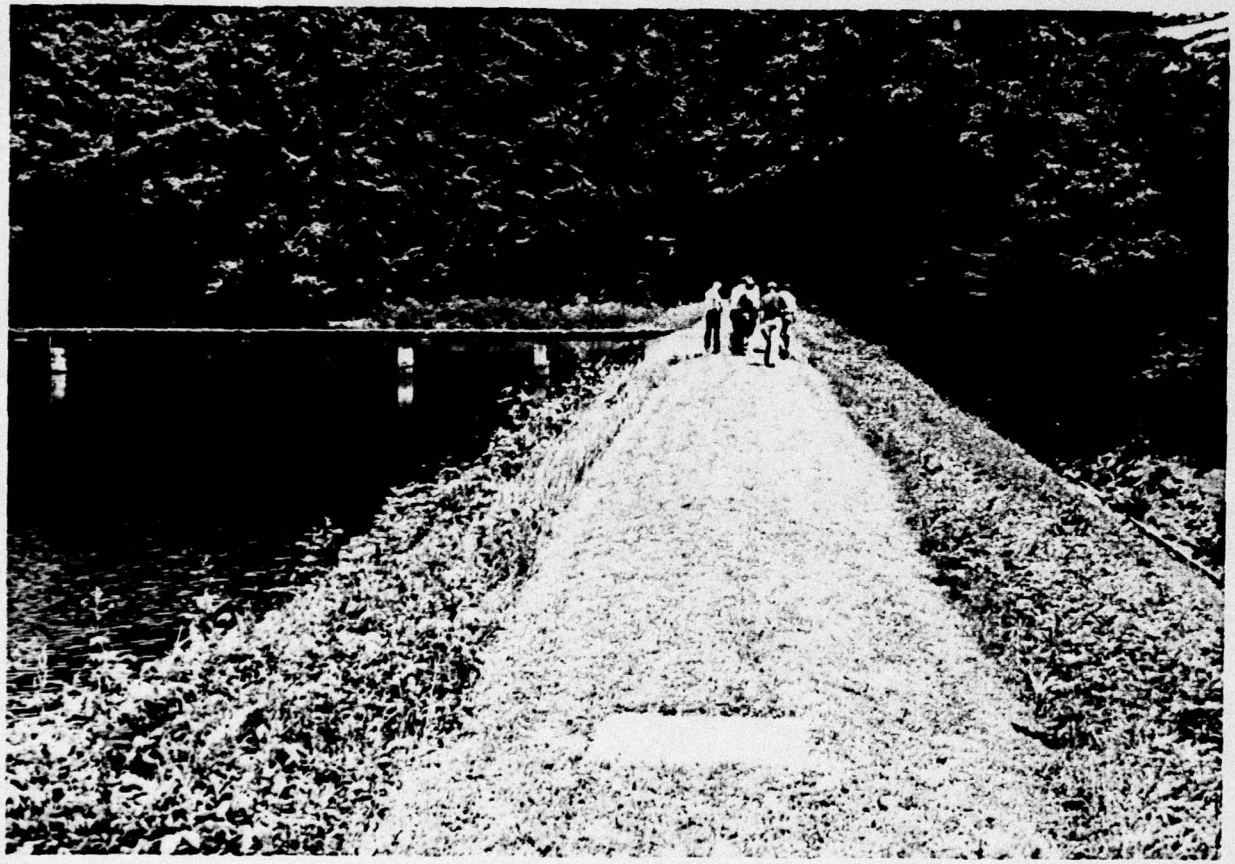
BERGER ASSOCIATES, INC.
HARRISBURG, PA.

DATE: August 24, 1979

APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE: 7 Sep 79



OVERVIEW

GLEN BROOK NO. 4 DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

GLEN BROOK NO.4 DAM

NDI-ID NO. PA-00650
DER-ID NO. 19-8

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

The Glen Brook No.4 Dam is an earthfill dam 250 feet in length plus a 34 foot long spillway. It is 47 feet high above the streambed. This dam is the last of three such dams constructed in this area. The other two dams, identified as No.1 and No.2 are in series with and are located upstream from No.4. The original dam, No.1, is completely submerged in the No.4 reservoir (with the exception of its control tower) and has no impact on the use of No.4 under normal conditions. The No.2 dam is located upstream of No.1. The present No.4 reservoir touches the downstream slope of this dam. A small ponded reservoir is created above the No.2 dam serving as a silt retention basin for the No.4 reservoir area. A description of the No.2 dam is included in Appendix A of this report, page A-6.

This entire system of dams forms a source of reserve water supply for the Borough of Berwick. Water lines are interconnected to allow the delivery of water, by gravity, to the Berwick water system in the event of prolonged power failure which would cause loss of the primary pumped water supply from another source. Refer to Appendix F, Plate No. III, for plan view of dam.

[cont'd on p. ii]

The spillway for the No.4 dam is located near the center of the dam embankment. The spillway is a broadcrested weir with flagstone paving as its surface in the crest area. Concrete training walls form the sides of the chute. The spillway chute drops sharply beyond the crest over a 1.5H to 1V paved channel to the stream level. The chute slope and bottom level section are paved with concrete slabs. A wooden deck on steel beams spans the spillway.

The water supply controls for No.4 dam are located in the control tower which is located 100 feet upstream from the embankment in the reservoir area. This tower is accessible by means of a wooden footbridge from the crest of the embankment. The emergency drawdown is a 20-inch diameter cast iron pipe which has both upstream and downstream control.

Dam Nos. 1 and 2 were constructed about 1904 and Dam No.4 was built in 1909.

B.	Location:	Briar Creek Township Columbia County, Pennsylvania U.S.G.S. Quadrangle, Berwick, PA. Latitude 41°-05.2', Longitude 76°-13.7' (Refer to Appendix F, Plates I and II)
C.	Size Classification:	Intermediate, Height 47 feet, 220 acre-feet.
D.	Hazard Classification:	High (Refer to Section 3.1.E)
E.	Ownership:	Keystone Water Company, Berwick District 106 East Second Street Berwick, Pennsylvania 18603
F.	Purpose:	Water Supply

G. Design and Construction History

The Glen Brook No.4 Dam was designed by T. Chalkley Halton, Consulting Engineer, in 1909. It was constructed in that same year by Antonio Cocoa, contractor. Information on the design and construction of this dam is very limited. The records in the PennDER files describe the embankment material as good quality clay placed in six inch layers and rolled. The dam contains a concrete core wall described as extending from three feet below the crest to three feet into rock. This core wall has a top width of three feet and an average bottom width of 11 feet. Pipes which extend through the embankment are supported on concrete piers.

As indicated earlier, this dam is one of three dams constructed in series in this area.

H. Normal Operating Procedures

The Glen Brook No.4 Dam and the upstream Dam No.2 (No.1 is submerged) are operated together as a reserve water supply for the Borough of Berwick.

1.3 PERTINENT DATA

Note: All elevations are to USGS datum.

A. Drainage Area (square miles)

From files	3.2
Computed for this report	2.8
Use	2.8

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations

Maximum known flood since construction of the dam, June 22, 1972	96
Outlet works low pool outlet at pool Elev. 725	33
Outlet works at pool level Elev. 758.2 (spillway crest)	57
Warm water outlet	None
Spillway capacity at pool Elev. 761.4 (low point, top of dam)	550

C. Elevation

Top of dam	762.1
Low point in dam	761.4
Spillway crest	758.2
Upstream portal invert (20-inch concrete pipe)	Unknown
Downstream portal invert (20-inch concrete pipe), about	707.5

	Streambed at centerline of dam, about	715
D.	Reservoir (feet)	
	Length of normal pool	1,400
	Length of maximum pool	1,400
E.	Storage (acre-feet)	
	Spillway crest (Elev. 758.2)	194
	Top of dam (Elev. 761.4) from HEC-1	220
F.	Reservoir Surface (acres)	
	Top of dam (Elev. 761.4)	8.6
	Spillway crest (Elev. 758.2)	7.7

G. Dam (Refer to Appendix F, Plates III and IV)

Type: Earthfill embankment.

Length: 250 feet.

Height: 47 feet above streambed.

Top Width: 8 feet.

Breast Elevation: 762.1 (U.S.G.S. datum, see Plate A-II).

Side Slopes: Upstream 2.2H to 1V.
Downstream 1.5H to 1V with stone facing.

Core Wall: Three feet into rock and extending to within 3 feet of the top of the embankment.

Grouting: None reported.

H. Outlet Facilities

A concrete and masonry control tower is located about 100 feet upstream from the centerline of the dam. This house has openings at various levels. Two water supply lines (12-inch and 20-inch) exit this structure, along with a 20-inch blowoff line. The blowoff line extends from the upstream reservoir No.2 valve house, through the Reservoir No.1 and Reservoir No.4

Valve Houses, through the embankment to discharge in the down stream channel. The blowoff is connected by "Y" branches to the No.1 and No.4 valve houses and is controlled by valves in each of the three valve houses.

I. Spillway

Type: Uncontrolled broad crested weir (flagstone paved).

Length of weir: A total effective length of about 31.1 feet. It is divided into three bays by two 1.6 foot wide bridge piers.

Crest elevation: 758.2 mean sea level datum.

Bridge: A steel I beam footbridge spans the spillway and is located near the downstream edge of the crest. The under clearance varies from 3.4 feet to 3.7 feet (see Sheet 1, Appendix C).

Downstream channel: At the downstream edge of the weir is an 8-inch vertical drop followed by a steep, 35 feet wide, concrete lined channel. This channel extends to the toe of the embankment, where it makes a bend to the left and joins the bypass channel at the upstream side of the highway bridge where the natural channel begins. Refer to Appendix F, Plate No. III.

J. Regulating Outlets

See Section 1.3.H above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The design information for this dam is contained on the construction drawings. This information is very limited. There is no section of the No.4 dam on these drawings. The project was designed in 1909.

2.2 CONSTRUCTION

There are no records of the construction of this dam. The correspondence in the PennDER files describe the embankment material as good quality clay placed in six inch layers and rolled. Also that the material above and below the core wall was carefully selected. Reference to the core wall indicates that it was constructed of concrete as a trapezoidal section three feet thick at the top and 11 feet thick at its base. The top of the core wall is three feet below the top of the embankment and its base is seated three feet into the underlying rock formation.

2.3 OPERATION

There is no formal operating procedure for this dam. As mentioned earlier, this dam is used as a reserve water supply for the Borough of Berwick. The owners representative indicated that a small volume of water is taken from the reservoir daily. The controls to the supply lines are open at the dam and the withdrawal is controlled at some downstream location.

The reservoir drain line or blowoff has not been opened for at least the past seven years. It was not operated during this inspection.

Careful watch is made of the upstream dam No.2 during periods of heavy or prolonged rain with the intent of preventing flow of water over this dam's deteriorated spillway by allowing the inflow to bypass the reservoir through the concrete flume along the left side of the reservoir system.

2.4 EVALUATION

A. Availability

The engineering data for the Glen Brook Dam No.4 is very limited. There are no design criteria or calculations. Available information is found on drawings showing plans of the reservoir system including the upstream No.1 and No.2 dams. A section of the No.4 dam was not found.

The owners files contain all of the drawings that exist. The PennDER files contain only one plan view of the reservoir system.

B. Adequacy

The engineering information is not of sufficient detail to make a detailed evaluation of the design or construction of this dam.

C. Operating Records

There are no records of the operation of this dam.

D. Post Construction Changes

There are no records of any changes in the system, aside from maintenance and repairs, since the completion of construction in 1909.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Glen Brook No.4 Dam is fair. There were no seepage conditions noted on the slopes. Although water was not flowing over the spillway, water was discharging from three of four relief holes on the steeply sloping spillway channel slab. The visual inspection check list is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The earthfill embankment for this dam consists of two sections separated by a broadcrested weir near the middle of the crest length. The total length of the two sections is 293 feet. The spillway length between the embankment sections is 34 feet.

Although the inspection reports from 1924 through 1948 mention seepage at the toe near the left spillway wall and at the end of the wasteway channel, seepage was not reported after 1948 nor was it detected at this time on the downstream slope, at its toe, or beyond. A moderate growth of weeds covers the slope to the toe. Beyond the toe, the cover is closely mowed. The owner's representative reported that the slope cover is cut twice each year. The top of the embankment is grass covered, closely mowed and the upstream slope is covered with fern growth.

The slope ratios, as measured by survey during this inspection were 1.6H to 1V on the downstream slope and 2H to 1V on the upstream slope. Close observation of the slope surfaces did not detect any cracks, sloughs or any signs of distress. The slopes appear to be in stable condition.

The horizontal alignment of the embankment is good. The vertical profile, on the basis of the inspection survey, is shown in Appendix A, Plate A-II.

C. Appurtenant Structures

The appurtenant structures for this dam include an uncontrolled broadcrested weir spillway and spillway channel and an inlet control structure.

The spillway was observed to be in fair condition. It is a broadcrested weir formed of flagstone slabs with cement mortar in the joints. The slabs appear to have been recently maintained and appear to

be in reasonably good condition. The spillway chute, at a 1.5H to 1V slope ratio, is bounded by concrete walls. The wall sections are tilted slightly inward creating small projections into the channel between sections. This does not appear to be a serious condition, but it should be closely observed on a regular basis for possible progressive movement in the future.

A wooden footbridge on steel beams spans the spillway providing access from one side of the embankment to the other. The bridge is supported by the endwalls of the spillway structure and two concrete piers resting on the crest of the spillway. Refer to Appendix E, Plate E-I for photograph. A galvanized pipe handrail is located on the downstream side of the bridge deck.

The spillway chute slab contains four six-inch diameter weepholes located about 10 feet from the left wall and at vertical distances of about 13 feet between holes. The lowest hole is approximately 18-inches from the bottom of the chute slope. Three of the holes were discharging water. The top hole was dry. The estimated flow from the three holes is about 40 to 50 gallons per minute. A section of downspout was inserted into the bottom hole and extends about three feet out from the surface. Close examination of this hole observed that the section of downspout was loose and can easily be removed and that a cavity exists beneath the slab. The discharge was clear.

The spillway chute continues nearly horizontally to its termination beneath a roadway bridge. Refer to Appendix F, Plate No. III for plan view. The end of the slab shows some undermining but is not observed to be critical as the slab is sufficiently thick at this location. The drawdown or blowoff pipe discharges to the stream under the roadway bridge.

The intake structure for Dam No.4 is an enclosed concrete and brick building located about 100 feet upstream from the embankment. It contains seven control valves. Three of these are identified as a 12-inch water supply, 20-inch water supply and a 20-inch blowoff control. The remaining four valves could not be identified. None of the valves were operated at the time of this inspection. The building appears to be in structurally sound condition, although some concrete spalling occurs just above the water surface.

Access to the intake structure is by means of a wooden footbridge on steel beams. This bridge has no handrail and is in fair condition. The deck needs improvement.

The left side of the embankment slope abuts the wall of a concrete outlet channel for a 5-foot diameter flume. This flume begins upstream at Dam No.2 and parallels the left side of the reservoir area,

discharging at Dam No.4 into the downstream channel. The flume is not a part of Dam No.4. Refer to Appendix E for photographs of this outlet channel and its relationship to the embankment and the spillway outlet channel.

D. Reservoir Area

The reservoir area is fenced and not accessible to the public. Locked gates prevent entrance to this area. The area surrounding the reservoir is described as woodlands to the edge of the reservoir system. The slopes are moderate and stable. There are no signs of erosion. Dam No.2, upstream from No.4 serves as a sediment basin thus minimizing any sedimentation in the main reservoir.

E. Downstream Channel

The downstream channel is a natural stream with a state highway bridge immediately downstream and several houses located near the stream about one-half mile from the dam. The hazard category for this dam is considered to be "High".

3.2 EVALUATION

The visual inspection of this dam indicates that it is in fair condition. The slope cover is cut twice annually and no large brush or small trees exist. The condition of the flagstone spillway crest shows need for continuing maintenance. It is suspected that flood flow over this crest could displace the paving and cause serious damage to the spillway. The wooden decks on the footbridge leading across the spillway and to the intake tower are in need of repair including the addition of a handrail on the bridge to the intake tower. The spillway chute walls show slight tilting as evidenced by some displacement at the top. These areas should be smoothed and observed regularly for possible progressive movement.

The valve controls in the intake tower were not operated during the inspection. Future operation of this facility should include at least an annual opening and closing of the controls, especially the blowoff control.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Glen Brook No.4 Dam was constructed in 1909 as the third dam in a series of three dams which now provide a reserve water supply for the Borough of Berwick, Pennsylvania. The owner's representative indicated that the reservoir operates as a standby gravity flow source in the event of power failure which would shut down the Borough's primary pumped water supply.

The valves controlling the outlet of water from the reservoir to the Berwick system remain open as a regular condition. Admission of water from No.4 to the system is controlled downstream.

One 20-inch valve controls the 20-inch blowoff pipe. This valve and pipe serve as the emergency drawdown control for the reservoir.

The owner's representative indicated that these control valves have not been operated for at least the past seven years.

4.2 MAINTENANCE OF DAM

The regular maintenance of the dam includes the control of the weed growth on the embankment slopes, repair of flagstone slabs and concrete walls and footbridge deck replacement. The slope maintenance is conducted twice each year when the weeds are cut and removed. The maintenance of the other items is conducted on an as required basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities for this dam involve the water supply valves and the blowoff control. There is no regular maintenance program for the operation of these controls.

4.4 WARNING SYSTEM

There is no formally organized surveillance or warning system in operation for this facility; although, there is radio contact between the attendants vehicle and the owners office.

4.5 EVALUATION

The maintenance of the embankment appears to be satisfactory with the twice a year removal of the weed growth. The operational procedures should be improved to include the operation and service of the valves in the control house at least once each year. This applies especially to the blowoff control for emergency release of water or drawdown of the reservoir.

A formal surveillance and downstream warning system should be developed for use during periods of prolonged or heavy rainfall.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

Very little information is available on the hydrologic and hydraulic design of the dam. There are no area-capacity curves, frequency curves, unit hydrographs, design storm data, design flood hydrographs, flood routings nor spillway rating curves.

B. Experience Data

There are no records available for past floods, but personnel of the Keystone Water Company reported that the maximum known flood occurred in June, 1972. At that time the water level rose to an elevation of about one foot above the spillway crest.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped.

The steel I-beam bridge over the spillway weir might reduce the capacity of the spillway at high pool stages (see Sheet 1 of Appendix C). The flagstone paving at the spillway crest could be damaged by a high discharge.

D. Overtopping Potential

Glen Brook No.4 Dam has a total storage capacity of 220 acre-feet and an overall height of 47 feet above streambed, both referenced to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the full Probable Maximum Flood (PMF). For this dam, the PMF peak inflow is 6,032 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 6,032 cfs with the estimated spillway discharge capacity of 510 cfs indicates that a potential for overtopping the Glen Brook No.4 Dam does exist.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 10% of a PMF without overtopping.

E. Dam Break Evaluation

The calculations to determine the behavior of the dam in the event of an overtopping and a resulting breaching of the embankment indicates that there will be a substantial increase in water levels downstream from the dam.

Several houses are located about 2,750 feet downstream from the dam. On the basis of the results of a dam break analysis, using the U.S. Army Corps of Engineers HEC-1 program, the water surface elevation in the vicinity of the houses would be about 655.8 when the water surface in the reservoir above the dam is just at the crest elevation (low point) of the embankment (no overtopping). (Refer to Table 1, Appendix C). It is expected that 18 percent of a PMF would cause the water level in the lake to reach an elevation that would result in a breach (one foot above crest elevation). Just prior to failure by the 18 percent PMF flow, the water surface elevation 2,750 feet downstream would be about 656.5. The increase due to overtopping under no failure condition would be approximately (656.5 - 655.8) 0.7 feet. While more property would be exposed to flooding, the increase to the danger of loss of life is not considered significant. With failure, however, the breaching analysis indicates a rise of about 3.1 feet above the flow level just prior to breach when considering a 15 minute time to complete the breach and a 1.6 feet rise above flow level just prior to breach when considering a 2 hour time to complete the breach. The increase in hazard to loss of life and property damage is reflected not only in the increase in depth of water of 3.1 feet in the 15 minute breach and 1.6 feet in the 2 hour breach, but more significantly in the shorter time to reach the peak. Less time would be available to respond to the flooding under the breach conditions.

Being an earth embankment with a concrete core wall, it is judged that a breach is likely to develop when the depth of flow over the crest is one foot or greater and that the breach would be completed between the 15 minute and the 2 hour period. The numerical difference of water levels is 1.5 feet. The property damage would be similar with either failure time. Again, however, the time factor is most significant regarding loss of life. Calculations indicate that the water depth will increase at a rate of 3.1 feet in 15 minutes under the 15 minute breach condition.

On the basis of these calculations, it is concluded that the hazard to loss of life and property damage is significantly increased when the dam is overtopped as compared to the condition just prior to overtopping.

Refer to Table 1, Appendix C, for comparison of flood water levels.

F. Spillway Adequacy

The intermediate size category and high hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be the Probable Maximum Flood (PMF).

The calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 10% of the (PMF) without overtopping the dam. These calculations have considered the existing low point along the embankment crest.

Being an earth embankment with concrete core wall, it is judged that a breach is likely to develop when the depth of flow over the crest is one foot. These studies also indicate that the depth of flow over the crest of the embankment due to one-half PMF is more than the one foot criteria. On the basis of this information, it is judged that a one-half PMF will cause overtopping of the embankment and will most likely cause a breach. When compared to the hazard to loss of life downstream from the dam just prior to failure, the calculations indicate that the hazard, as a result of a dam failure is significantly increased. Therefore, the spillway capacity is considered to be seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

There were no indications of embankment distress or instability as a result of the visual inspection. The surveyed profile on the crest of the embankment show a variation of .6 feet between the high and low point. The upstream and downstream slope ratios were surveyed as 2.2H to 1V and 1.6H to 1V respectively. Although the downstream slope is steeper than the embankment slopes designed today, engineering practice in 1909 commonly used this criteria, and since there was no visible signs of distress, it is apparently in a stable condition.

2. Appurtenant Structures

The appurtenant structures for Dam No.4 include the uncontrolled spillway, the intake control tower, the blowoff outlet pipe and the wooden deck footbridges across the spillway and to the intake control tower. An additional structure, the outlet channel to a flume which parallels the left side of the entire reservoir, while not an integral part of the No.4 Dam, would have influence on the stability of the left portion of the earth embankment. Refer to Appendix F, Plate III for this relationship.

The uncontrolled spillway is considered to be in fair condition. The flagstone paving on the crest is reasonably maintained and is sealed with mortar at the joints. The behavior of these slabs under flood or extremely heavy flow is unknown. The outlet channel drops at a rate of 1.5±H to 1V to a nearly horizontal slab at the bottom near the elevation of the natural stream channel. The training wall sections of this channel show evidence of some tilting inward toward the channel. The tilting is not severe, but some slight projections between the sections exist. These projections could possibly aggravate the condition during high flow through the channel. Providing a fillet to create a smoothed surface across the projections would improve the condition. Evidence of other surface repair was observed along the walls on both sides of the channel. The bottom slab and walls below the sloped section appear to be stable and in good condition.

The wood deck footbridge across the spillway should be improved to assure safe access to both sides of the embankment.

The intake structure appears to be stable. The steel beam wooden deck footbridge is usable but it does not have a handrail. Installation of a handrail for safety purposes should be considered. Repairs to the wooden deck should be included in the regular maintenance program.

The blowoff outlet pipe discharged directly to the natural stream beneath a concrete roadway bridge. The channel is unobstructed in this area and should allow free flow of water from the pipe.

The right wall of the outlet channel from the flume mentioned above forms the left abutment for the earth embankment. The wall of this channel also show some slight tilting. Repairs to the surface of these walls is in evidence. Except for the slight misalignment between wall sections, there is no evidence of instability.

Close and continued observation should be made of the spillway outlet channel and flume outlet channel walls on a regular basis to detect any change in the wall posture that could jeopardize the stability of the entire dam.

B. Design and Construction Data

Design or construction data that would permit an evaluation of the stability of the dam or its appurtenant structures were not found in the PennDER or the owners files.

C. Operating Records

Other than records of withdrawal of water from the reservoir for water supply surposes, there are no records on the regular operation of this dam.

D. Post Construction Changes

There are no records or reports of any changes to this dam since the completion of construction in 1909.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 7 - ASSESSMENT & RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of the design drawings and the historical records of the development and operation indicates that this dam is in fair condition. The inspection did not detect any signs of major distress on or in the vicinity of the embankment. There were also no signs of seepage. There were several items noted which require maintenance attention. These include continued slope cover control, repairs to wooden bridge decks and repairs to correct the slightly displaced spillway outlet channel walls.

In accordance with the Corps of Engineers evaluation guidelines, the spillway is inadequate for passing the full PMF peak inflow without overtopping the dam. The combination of storage and spillway capacity is sufficient for passing only 10 percent of the PMF and is, therefore, classified as seriously inadequate. Failure of this dam will significantly increase the hazard to loss of life downstream from the dam. The project, therefore, is considered to be unsafe, non-emergency.

B. Adequacy of Information

Although the available engineering data are not sufficient to make a detailed analysis of the stability of the dam and its appurtenant structures, the available drawings, reports and the observed physical conditions are judged sufficient for making a reasonable assessment of the overall condition of the dam.

C. Urgency

The recommendations presented below should be implemented without delay.

D. Necessity for Additional Studies

A detailed hydrologic and hydraulic analysis should be performed by a professional engineer experienced in the design and construction of dams to determine means for improving the capacity of this spillway and reservoir system.

7.2 RECOMMENDATIONS

A. Facilities

In order to assure the safe operation of this dam, the following recommendations are presented for implementation by the owner.

1. That a detailed hydrologic and hydraulic engineering analysis be made by a professional engineer with experience in the design and construction of dams to determine means for improving the capacity of the spillway and reservoir system so that it will meet the requirements of the Commonwealth of Pennsylvania.

2. That the valve controls in the intake tower be operated and greased on an annual basis to assure their use in the case of an emergency. This is especially applicable to the 20-inch blowoff control.

3. That maintenance of the flagstone forming the spillway crest be continued to provide a smooth entrance into the spillway chute and that the slight projections on the spillway chute walls be smoothed for better flow characteristics and to minimize further aggravation of the condition.

4. That the bridge decks across the spillway and to the intake tower be repaired and that a handrail be placed on the bridge to the tower.

5. That the source of seepage from the weepholes on the spillway chute slab be identified and that the cavity beneath the chute slab at the location of the lowest weephole be investigated and repaired.

B. Operation and Maintenance Procedures

1. That the regular maintenance of the dam embankment continue and that annual inspections be made and reported as to the findings of these inspections. Inspection items to include seepage, embankment slope condition and spillway crest and wall conditions.

2. That a formal surveillance and downstream warning system be developed to be used during periods of heavy or prolonged rainfall.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 19-8 NDI NO. PA-00 650

NAME OF DAM Glen Brook Dam No.4 HAZARD CATEGORY High

TYPE OF DAM Earth Embankment

LOCATION Briar Creek TOWNSHIP Columbia COUNTY, PENNSYLVANIA

INSPECTION DATE 6/20/79 WEATHER Sunny - Warm TEMPERATURE 70 - 80

INSPECTORS: R. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

H. Jongsma Ira Smith

R. Shireman William Waltman

J. Watson Bruce Juergen

Bill Hutcheson

NORMAL POOL ELEVATION: 758.2 AT TIME OF INSPECTION:

BREAST ELEVATION: 762.1 POOL ELEVATION: 757.2±

SPILLWAY ELEVATION: 758.2 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 1972

GENERAL COMMENTS:

Has never overtopped.
Radio contact for downstream warning.
Basically reserve supply - used partially every day.

NDI NO. PA-00 650

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None observed on the top - grassed. None observed on downstream slope - high weed cover throughout.
B. UNUSUAL MOVEMENT BEYOND TOE	None.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None evident - slopes covered with weeds.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal good. See survey profile Appendix A, Plate A-II.
E. RIPRAP FAILURES	None upstream, however, covered with weeds.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	4 weepholes located on paved spillway slab. Bottom one has downspout extending horizontally (located about 16" from bottom of spillway chute. Cavity behind slab. Three are discharging.
H. DRAINS	None evident.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Top - mowed grass. Downstream Slope - high brush cut twice each year. Upstream Slope - (very short) covered with fern growth.

NDI NO. PA-00 650

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Tower upstream in reservoir.
B. OUTLET STRUCTURE	24" pipe ends under bridge downstream.
C. OUTLET CHANNEL	Paved to bridge.
D. GATES	Seven valves - two water supply 12" and 20". One blowoff control 20", other four unknown. Preferred not to open because of loss of water.
E. EMERGENCY GATE	Blowoff. Upstream and downstream 20" control.
F. OPERATION & CONTROL	Valves in intake structure not operated in long time.
G. BRIDGE (ACCESS)	Wooden footbridge - access to tower, no handrail.

NDI NO. PA-00 650

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Directly from reservoir - wall on left side vertical crack through wall at crest of weir. Right approach wall - slight vertical crack at same location.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Broadcrested weir - slope parallels the downstream embankment slope. Walls appear to have been recently repaired and patched. Slabs appear to be in reasonably good condition - no displacement. Flagstone paving forms weir overhanging downstream slab.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Spillway chute ends at bridge. Chute walls tilt inward, creating slight projections at the joints. Cracks in between flat stone slabs filled with mortar.
D. BRIDGE & PIERS	Wooden footbridge access across spillway.
E. GATES & OPERATION EQUIPMENT	None. (Staff gauge on intake structure.)
F. CONTROL & HISTORY	About 1' above weir with Agnes (1972)

NDI NO. PA-00 650

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	On Intake Structure.
Other	
RESERVOIR	
Slopes	Wooded.
Sedimentation	None reported. Upstream reservoir probably receives all sediment.
Watershed Description	Wooded
DOWNSTREAM CHANNEL	
Condition	Natural stream, rocky.
Slopes	Stable.
Approximate Population	Over 100 (Berwick).
No. Homes	State highway and one home directly below spillway. Many homes further downstream.

Visual Observations and Notes of Upstream Dam No.2

The top of the dam is mowed grass and the upstream and downstream slopes are covered with weeds.

The spillway is severely deteriorated with displaced flagstone slabs, cracked side walls and general deterioration.

There is an upstream control tower with a 20" blowoff pipe which discharges below the No.4 Dam at the bridge.

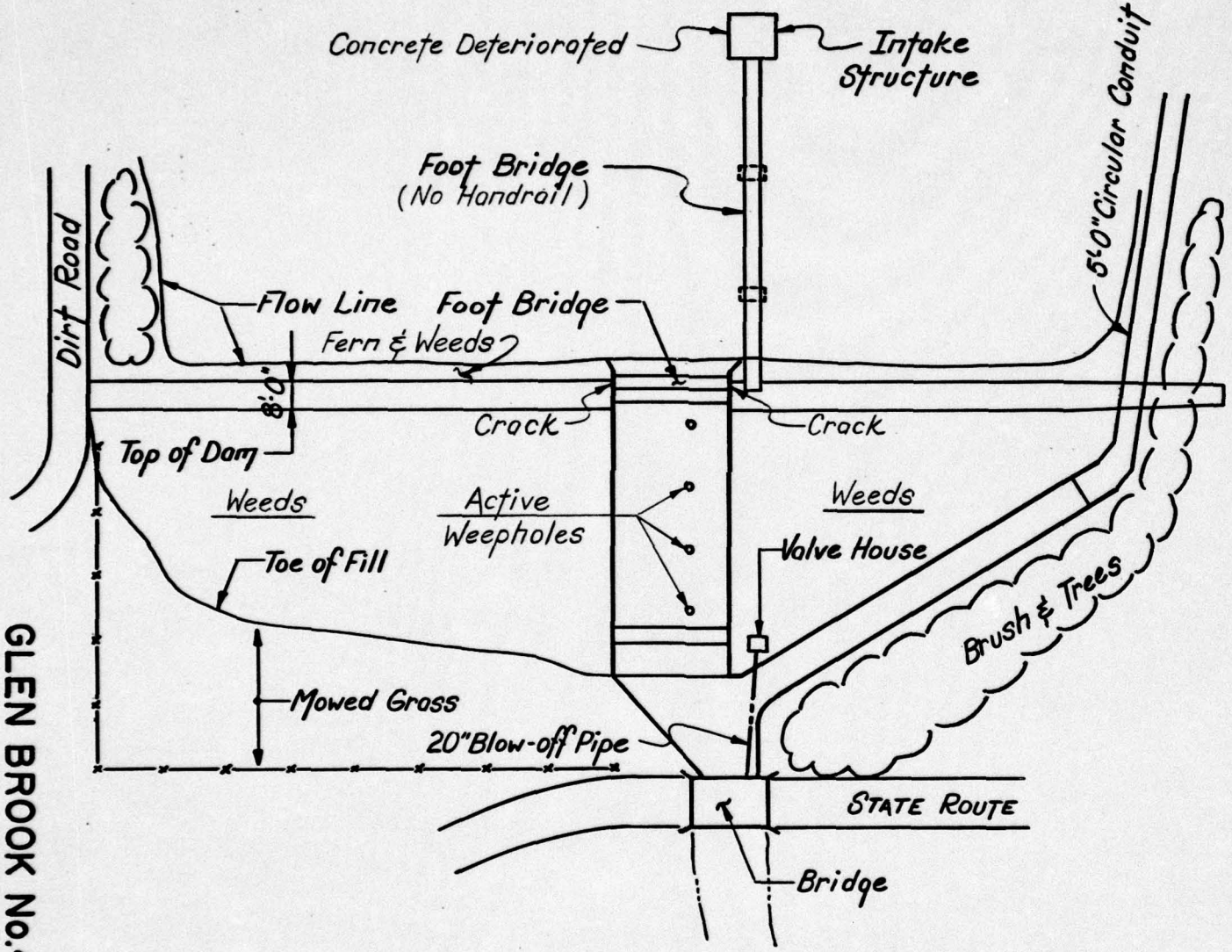
At the left abutment is an outlet controlled by a 60-inch diameter wooden butterfly gate which discharges into a concrete lined flume. This flume runs parallel along the left side of the reservoir. A portion of the flume, in the vicinity of Dam No.1, is underground. The flume discharges into an open channel at the left side of Dam No.4.

This dam (No.2) was overtopped in 1972 by about 1-1/2 feet of water. Several deep erosion scars remain on the downstream slope of the embankment as a result of this storm.

The downstream reservoir water surface for Dam No.4 was increased by about 1-1/2 feet - 2 feet during this event.

No.2 Dam Reservoir is small. The owners observed this dam closely during heavy storms to prevent water from passing over the main spillway. This is accomplished by opening the 20-inch blowoff pipe and the wooden butterfly gate. The structure, housing the wooden gate is in very poor condition inside.

4

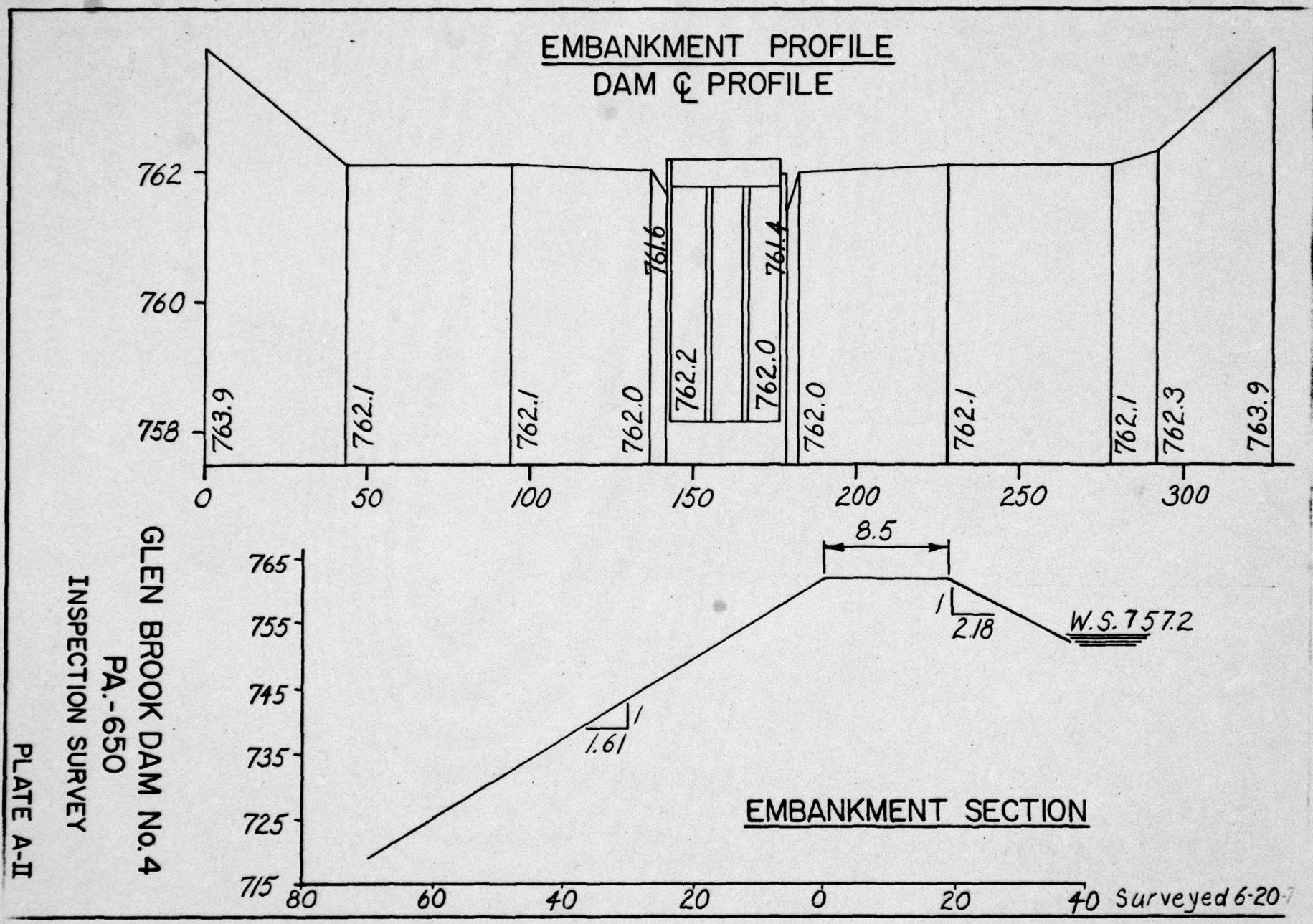


PLAN-GLEN BROOK No.4 DAM

Surveyed 6/20/79

GLEN BROOK No.4 DAM
PA.650
INSPECTION SURVEY

PLATE A-I



GLEN BROOK DAM No.4
PA.-650
INSPECTION SURVEY

PLATE A-II

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 19-8 NDI NO. PA-00 650

NAME OF DAM Glen Brook No.4 Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle Berwick, Pennsylvania See Plate II, Appendix F
CONSTRUCTION HISTORY	None.
GENERAL PLAN OF DAM	Plans available in the owner's Berwick office and their office in Camp Hill, PA.
TYPICAL SECTIONS OF DAM	A section of this dam is not found in any of the files.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	Plan views in the existing drawings. No other information.

NDI NO. PA-00 650

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

NDI NO. PA-00 650

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None - Inspection reports by the Commonwealth.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None.
MAINTENANCE & OPERATION RECORDS	For water supply records only.
SPILLWAY PLAN, SECTIONS AND DETAILS	None.

NDI NO. PA-00 650

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	Plan views on owners drawings.
CONSTRUCTION RECORDS	None.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	None.
MISCELLANEOUS	

NDI NO. PA-00 650

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded and farmland.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 758.2 194 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev.761.4 220 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 762.1

TOP DAM: Elev. 761.4

SPILLWAY:

a. Elevation 758.1

b. Type Uncontrolled Broadcrested

c. Width 31.1' divided into 3 bays.

d. Length 8 feet.

e. Location Spillover Center of dam

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 20" blowoff line, 20" and 12" water supply lines

b. Location From intake tower near upstream toe.

c. Entrance inverts Unknown

d. Exit inverts 707.5±

e. Emergency drawdown facilities 20" blowoff line

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

TABLE NO.1

COMPARISON OF WATER SURFACE ELEVATIONS

GLEN BROOK NO.4 RESERVOIR

PMF = 6,032 cfs

Crest Elevation - 762.1 Low Point - 761.4 Spillway Elevation - 758.2

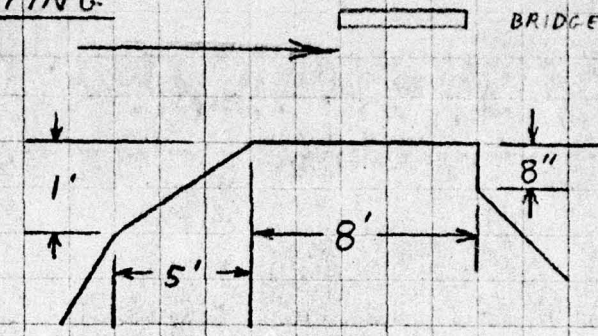
	STAGE	CREST OF DAM ELEVATION	CREST OF DAM DEPTH	2,750' D/S of DAM* ELEVATION
A.	At Low Point in Embankment Crest	761.4	0	655.8
B.	18% PMF Overtopping No Breach	762.42	1.02	656.5
C.	18% PMF Overtopping (15 Min. Breach)	763.38	1.98	659.6
D.	18% PMF Overtopping (2 Hour Breach)	762.62	1.22	658.1

*Several houses located about 2,750 feet downstream of Glen Brook No.4 Reservoir Dam.

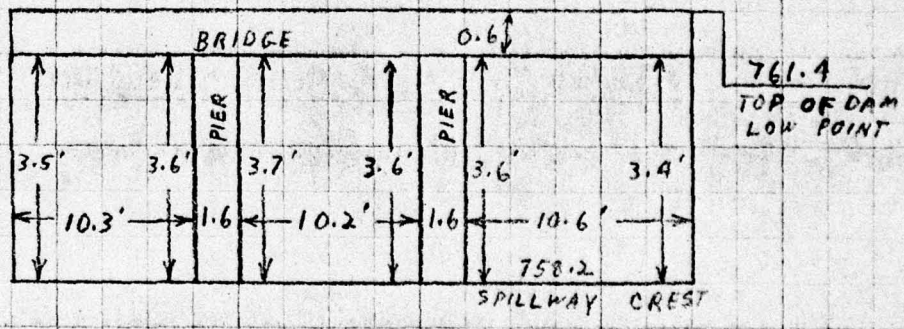
Condition C: (Time refers to elapsed time after start of storm).
Time to reach breach elevation 762.4 at dam = 41.75 Hours.
Water level 2,750' downstream at 41.75 Hours = 656.5.
Duration of breach = 15 Minutes.
Time for Breach to peak 2,750' downstream = .25 Hours.
Peak elevation 2,750' downstream due to breach = 659.6.
Rate of increase in water level = 3.1' in 15 Minutes.

BY RLS DATE 6/25/79 | BERGER ASSOCIATES | SHEET NO. 1 OF
CHKD. BY DATE | PROJECT D 8490
SUBJECT GLEN BROOK #4

SPILLWAY RATING



C = 3.1 (ESTIMATE FROM KING'S HDBK.)



$H = 761.4 - 758.2 = 3.2'$

$C = 3.1$

$L = 10.3 + 10.2 + 10.6 = 31.1'$

$$Q = C L H^{3/2}$$
$$= 3.1 \times 31.1 \times (3.2)^{1.5}$$
$$= 552 \quad \text{SAY} \quad 550 \text{ CFS}$$

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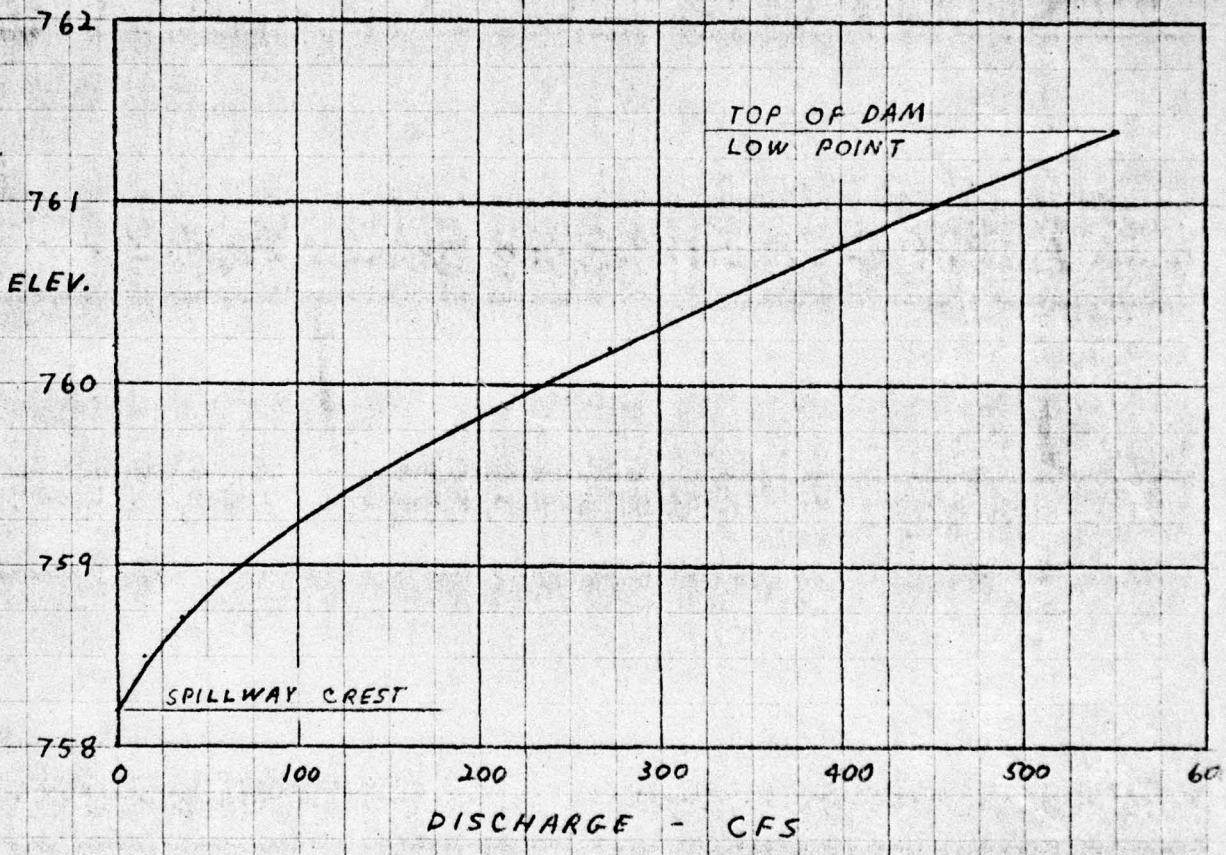
SUBJECT GLEN BROOK #4

SPILLWAY RATING CURVE



MAXIMUM KNOWN FLOOD AT DAM SITE

PERSONNEL OF THE KEYSTONE WATER COMPANY REPORTED THAT THE MAXIMUM KNOWN FLOOD AT GLEN BROOK #4 DAM OCCURRED IN JUNE 1972 WHEN THE WATER LEVEL IN THE RESERVOIR REACHED A STAGE OF 48' ON THE STAFF GAGE. THIS WOULD BE ABOUT 1' OVER THE SPILLWAY.

$C = 3.1 \quad L = 31.1' \quad H = 1'$

$Q = C L H^{3/2}$

$= 3.1 \times 31.1 \times (1)^{1.5} = 96$ CFS OVER SPILLWAY

BY RLS DATE 6/26/79 | BERGER ASSOCIATES | SHEET NO. 3 OF
CHKD. BY DATE | PROJECT D8490
SUBJECT GLEN BROOK #4

DISCHARGE THROUGH OUTLET WORKS

DISCHARGE THROUGH 20" DIAMETER CONCRETE PIPE
APPROXIMATE LENGTH = 220'
APPROXIMATE DOWNSTREAM INVERT ELEV. = 707.5

ESTIMATED DISCHARGE

AT NORMAL POOL ELEV. = 758.2
N = .015 (KING'S HDBK)
$A = \pi \times (20/12)^2/4 = 2.18$
$R = (20/12)/4 = .417$
$S = (758.2 - 708.3)/220 = .2268$

$Q = 1.486 \times A \times R^{2/3} \times S^{1/2}/N$
$= 1.486 \times 2.18 \times (.417)^{2/3} \times (.2268)^{.5}/.015$
$= 57$ CFS

AT LOW POOL ELEV = 725
$S = (725 - 708.3)/220 = .0759$

$Q = 1.486 \times A \times R^{2/3} \times S^{1/2}/N$
$= 1.486 \times 2.18 \times (.417)^{2/3} \times (.0759)^{.5}/.015$
$= 33$ CFS

BY RLL DATE 6/26/79 | BERGER ASSOCIATES | SHEET NO.
CHKD. BY DATE | PROJECT 084
SUBJECT GLEN BROOK #4

EMBANKMENT RATING

$Q = C L H^{3/2}$ C = 2.7 (KING'S HOBK.)

AT ELEV. 762

$2.7 \times 4 \times (.3)^{1.5} = 2$
$2.7 \times 4 \times (.2)^{1.5} = 1$ $\Sigma Q = 3$ CFS

AT ELEV 762.1

$2.7 \times 4 \times (.4)^{1.5} = 3$
$2.7 \times 4 \times (.3)^{1.5} = 2$
$2.7 \times 90 \times (.05)^{1.5} = 3$ $\Sigma Q = 8$ CFS

AT ELEV 762.3

$2.7 \times 4 \times (.6)^{1.5} = 5$
$2.7 \times 4 \times (.5)^{1.5} = 4$
$2.7 \times 90 \times (.25)^{1.5} = 30$
$2.7 \times 100 \times (.2)^{1.5} = 24$
$2.7 \times 14 \times (.1)^{1.5} = 1$ $\Sigma Q = 64$ CFS

AT ELEV 762.9

$2.7 \times 4 \times (1.2)^{1.5} = 14$
$2.7 \times 4 \times (1.1)^{1.5} = 12$
$2.7 \times 90 \times (.85)^{1.5} = 190$
$2.7 \times 100 \times (.8)^{1.5} = 193$
$2.7 \times 14 \times (.7)^{1.5} = 22$
$2.7 \times 22 \times (.4)^{1.5} = 15$
$2.7 \times 14 \times (.3)^{1.5} = 6$ $\Sigma Q = 452$ CFS

AT ELEV 763.9

$2.7 \times 4 \times (2.2)^{1.5} = 35$
$2.7 \times 4 \times (2.1)^{1.5} = 33$
$2.7 \times 90 \times (1.85)^{1.5} = 611$
$2.7 \times 100 \times (1.8)^{1.5} = 652$
$2.7 \times 14 \times (1.7)^{1.5} = 84$
$2.7 \times 50 \times (.9)^{1.5} = 115$
$2.7 \times 36 \times (.8)^{1.5} = 70$ $\Sigma Q = 1600$ CFS

AT ELEV 764.9 TOTAL Q = 5040
765.5 6488

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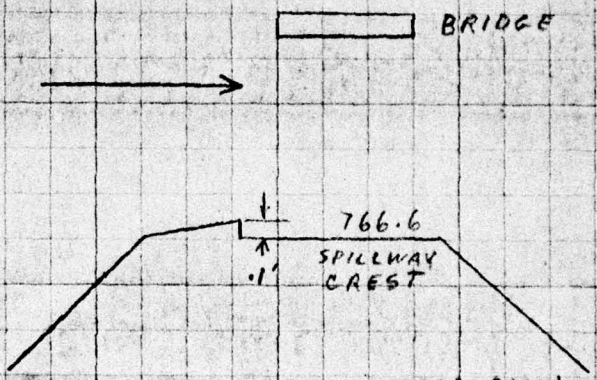
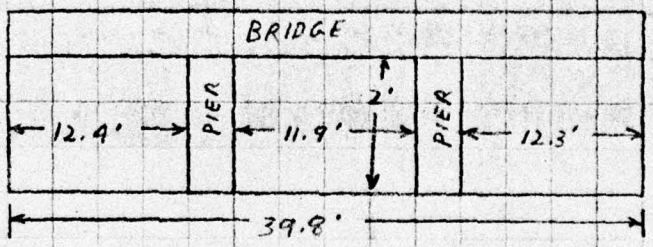
CHKD. BY DATE | PROJECT

SUBJECT GLEN BROOK #4

SPILLWAY RATING - GLEN BROOK #2



C = 3.1 (ESTIMATED FROM KING'S HDBK.)



L = 11.9 + 12.4 + 12.3 = 36.6'

C = 3.1

H = 2'

$$Q = C L H^{3/2}$$

$$= 3.1 \times 36.6 \times 2^{1.5}$$

$$= 320 \text{ CFS}$$

EMBANKMENT ELEV 769.4 GRASS SURFACE

USE C = 2.7 L = 170

BY RLS DATE 6/26/79 | BERGER ASSOCIATES | SHEET NO. 6 OF
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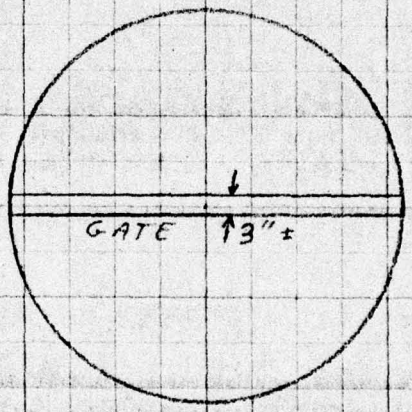
SUBJECT GLEN BROOK #4

DISCHARGE RATING - GLEN BROOK #2 BYPASS CHANNEL

DISCHARGE CONTROLLED BY BUTTERFLY VALVE (CHAINED IN OPEN POSITION) DIAMETER = 6'
INVERT ELEV = 761.0



APPROX. S = .00074

N = .017 (KING'S HDBK)

$A = (\pi \times 6^2/4) - (.25 \times 6)$
$= 26.77$

$P = (\pi \times 6) + (2 \times 6)$
$= 30.85$

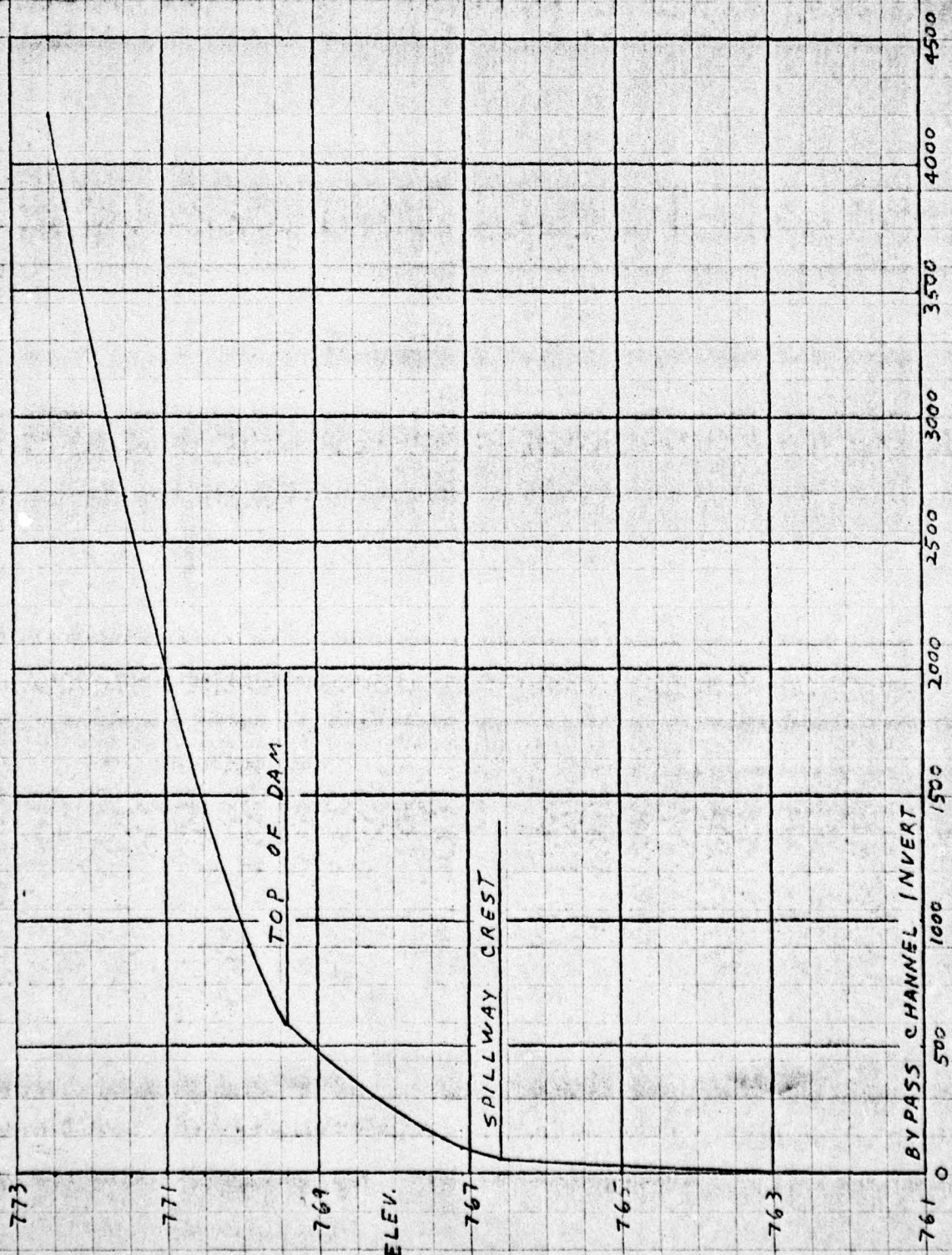
$R = 26.77/30.85 = .868$

$Q = 1.486\, A\, R^{2/3}\, S^{1/2}/N$
$= 1.486 \times 26.77 \times (.868)^{2/3} \times (.00074)^{.5}/.017$
$= 58$ CFS

THIS DISCHARGE DOES NOT FLOW INTO GLEN BROOK #4, AND IS ADDED TO RATING CURVE FOR GLEN BROOK #4

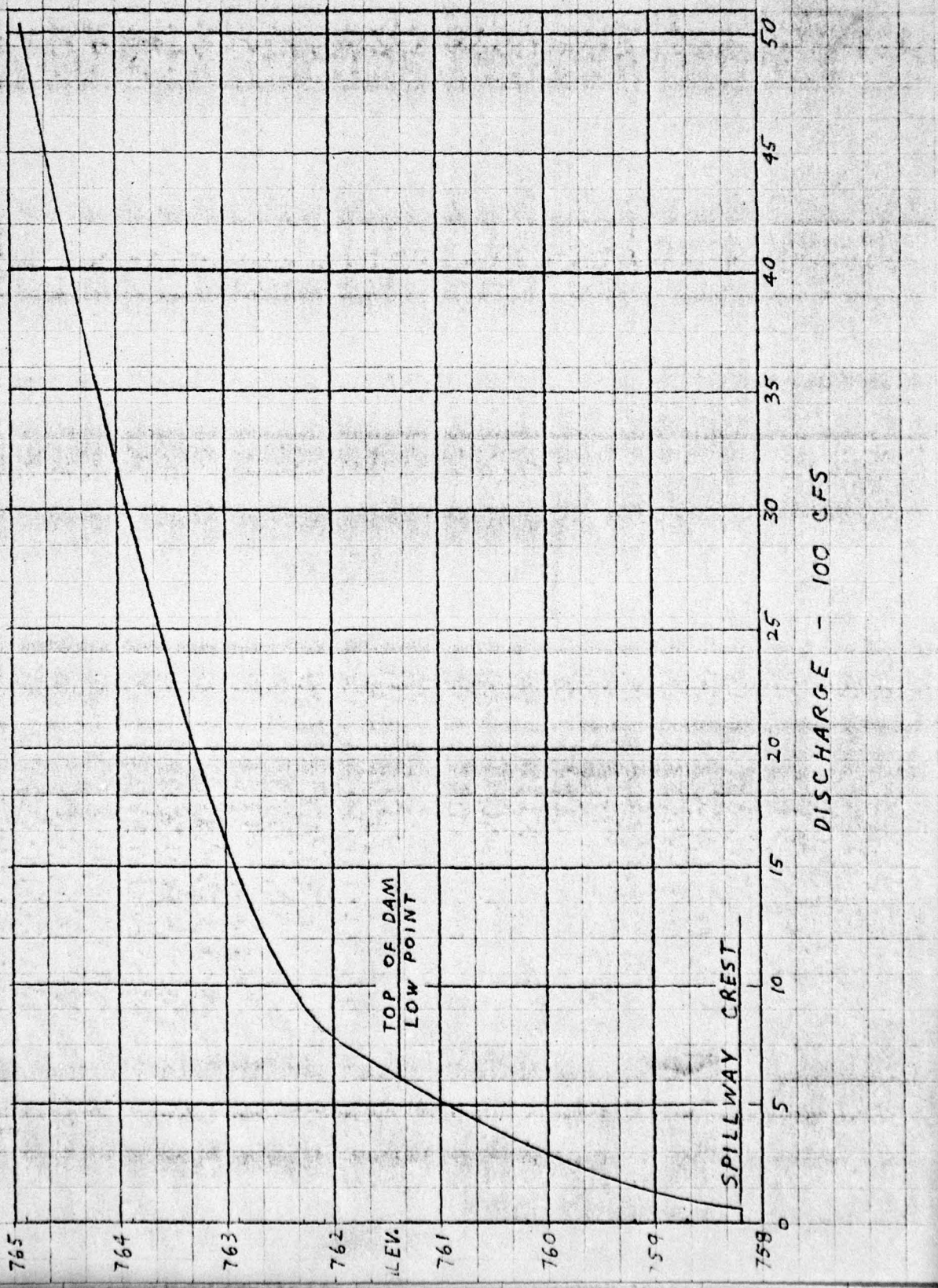
BY RLS DATE 6/27/79 BERGER ASSOCIATES SHEET NO.
CHKD. BY DATE PROJECT D8490
SUBJECT GLEN BROOK #4

DISCHARGE RATING CURVE - GLEN BROOK # 2



BY RLS DATE 6/27/79 BERGER ASSOCIATES SHEET NO. 2 OF
CHKD. BY DATE PROJECT D8490
SUBJECT GLEN BROOK #4

DISCHARGE RATING CURVE



BY RLS DATE 6/22/79 | BERGER ASSOCIATES | SHEET NO. 1 OF
CHKD. BY DATE | PROJECT D8490
SUBJECT GLEN BROOK #4

SIZE CLASSIFICATION

MAXIMUM STORAGE = 220 ACRE-FEET
MAXIMUM HEIGHT = 47 FEET
SIZE CLASSIFICATION IS INTERMEDIATE

HAZARD CLASSIFICATION

SEVERAL HOUSES ARE LOCATED ALONG THE DOWNSTREAM CHANNEL.
USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE PROBABLE MAXIMUM FLOOD.

BY RLS DATE 6/22/79 BERGER ASSOCIATES SHEET NO. 11 OF
CHKD. BY DATE PROJECT D8490
SUBJECT GLEN BROOK #4

HEC-1 DATA

DRAINAGE AREA = 2.8 SQ. MI.
GLEN BROOK #4 SUB AREA = 0.1 SQ. MI.
GLEN BROOK #2 SUB AREA = 2.7 SQ. MI.

SUSQUEHANNA BASIN REGION 13
$C_P = 0.5$
$C_T = 1.85$

GLEN BROOK #2 SUBAREA
LONGEST WATERCOURSE = 1.95 MI.
L TO CENTROID = 0.92 MI.

$$T_P = C_T (L \times L_{CA})^{.3}$$
$$T_P = 2.2$$

GLEN BROOK #4 SUBAREA
L' END OF RESERVOIR TO BASIN DIVIDE = .36 MI.

$$T_P = C_T (L')^{.6}$$
$$T_P = 1.0$$

RAINFALL (HMR-40)
INDEX = 22.2"

INCREMENTAL RAINFALL
6 HR = 117.5 %
12 HR = 127 %
24 HR = 136.5 %
48 HR = 142.5 %
72 HR = 145 %

BY RLS DATE 6/22/79 | BERGER ASSOCIATES | SHEET NO. 11 OF
CHKD. BY DATE | PROJECT 08490
SUBJECT GLEN BROOK #4

HEC-1 DATA

GLEN BROOK #2

STORAGE = 30.7 AC-FT.

PLANIMETERED AREAS (FROM QUAD SHEETS)

ELEV.: 761 = 2.9 ACRES

780 = 9.2 ACRES

ZERO STORAGE ELEV.

ELEV = 761 - (STORAGE x 3/AREA)

= 729.3

GLEN BROOK #4

STORAGE = 194.5 AC-FT.

PLANIMETERED AREAS (FROM QUAD SHEETS)

ELEV.: 758.2 = 7.7 ACRES

780 = 13.8 ACRES

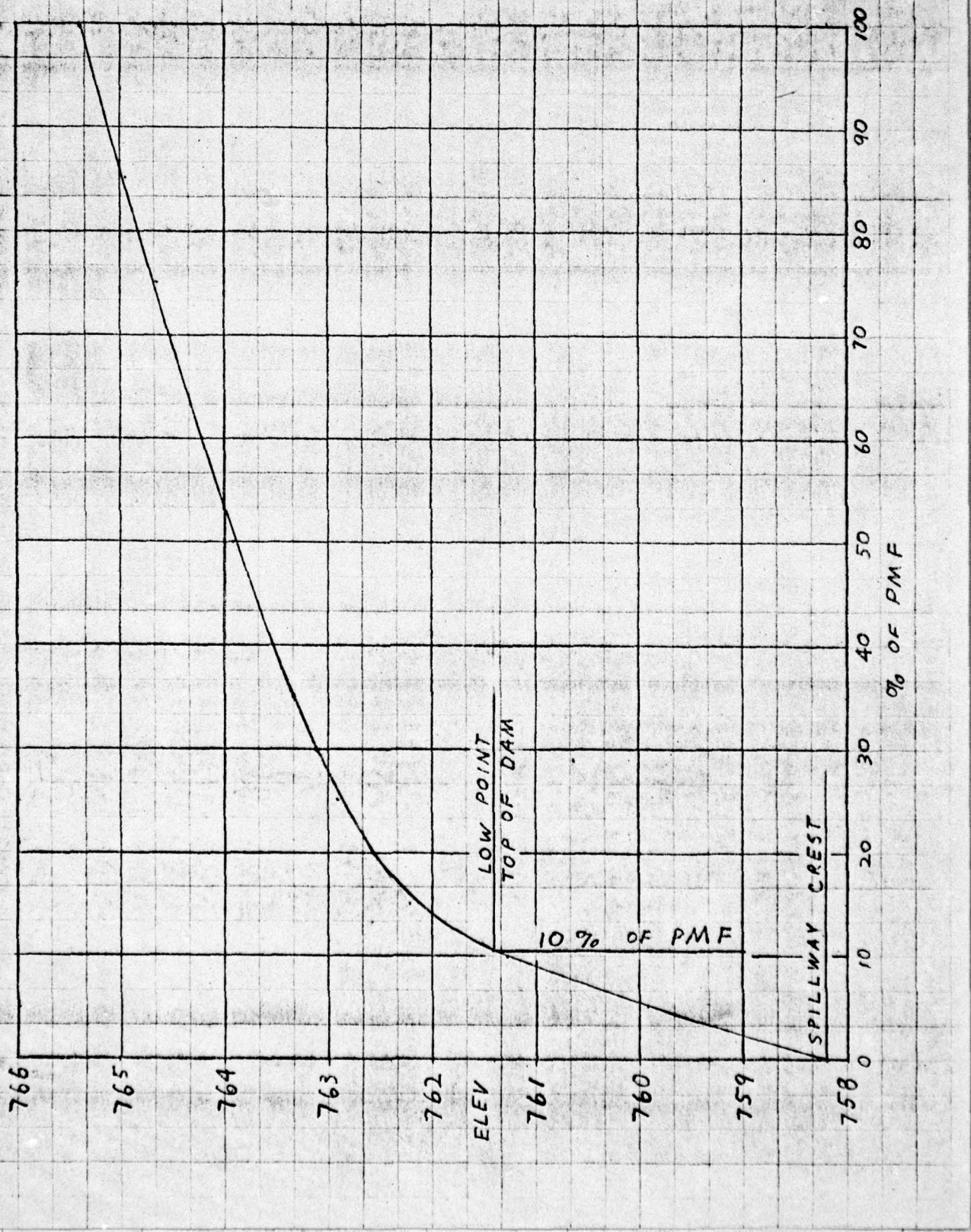
ZERO STORAGE ELEV.

ELEV = 758.2 - (STORAGE x 3/AREA)

= 682.5

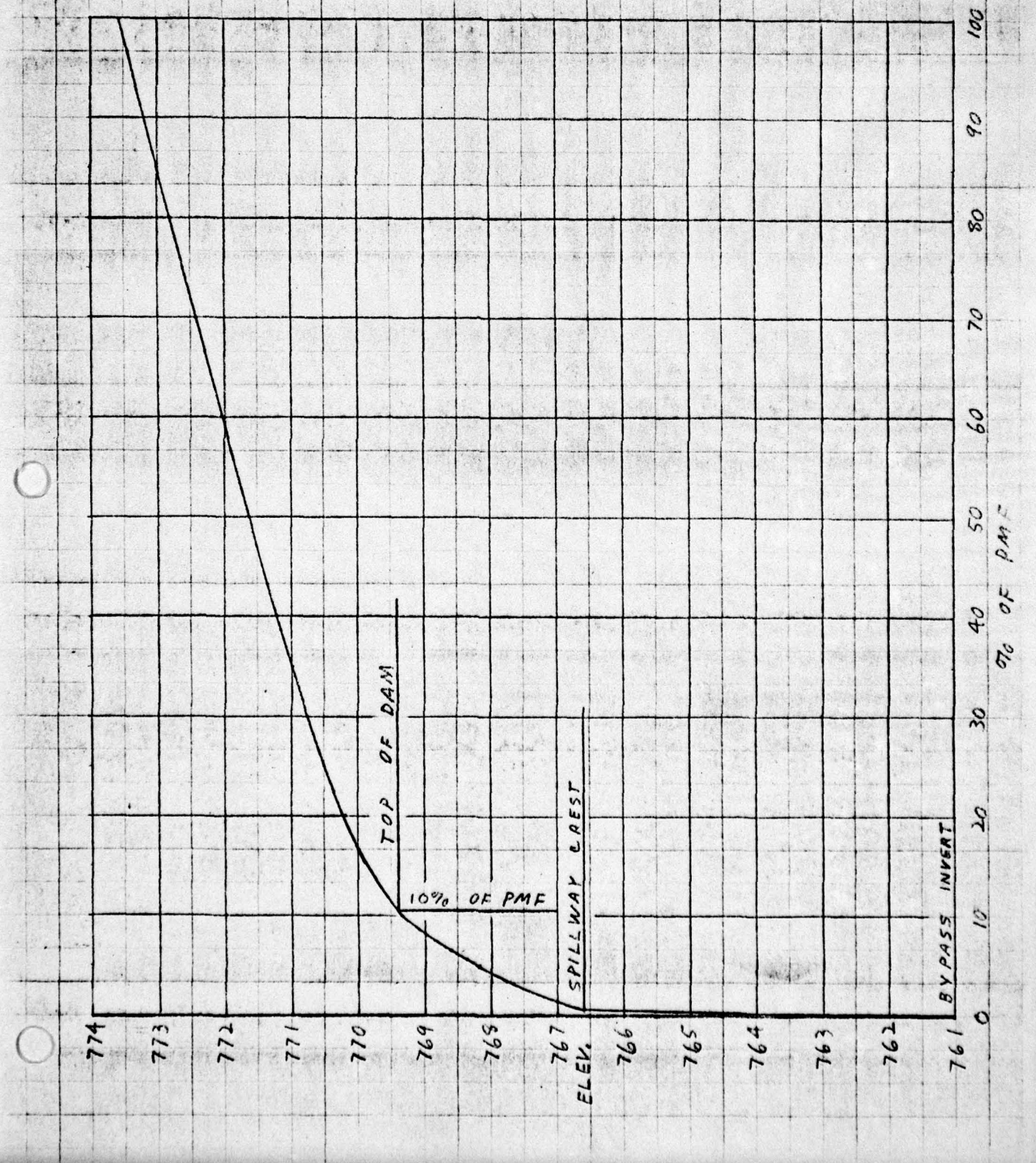
BY RLS DATE 7/6/79 BERGER ASSOCIATES SHEET NO. 12 OF
CHKD. BY DATE PROJECT D8490
SUBJECT GLEN BROOK #4

SPILLWAY CAPACITY CURVE



BY RLS DATE 7/9/79 BERGER ASSOCIATES SHEET NO. 13 OF
CHKD. BY DATE PROJECT D8490
SUBJECT GLEN BROOK #4

SPILLWAY CAPACITY CURVE - GLEN BROOK NO. 2



BY RLS DATE 8/15/79 | BERGER ASSOCIATES | SHEET NO. 14 OF
CHKD. BY DATE | PROJECT 1849
SUBJECT GLEN BROOK

BREACH ASSUMPTIONS

RESERVOIR # 2

BREACH WIDTH = 50'

SIDE SLOPES (EARTH EMBANKMENT) = 1:1

FAILURE TIME (EARTH EMBANKMENT) =
BETWEEN 15 MIN. AND 2 HR.
USE: .25 HR., .5 HR., 1.0 HR., 2.0 HR.

POOL LEVEL AT FAILURE: EARTH EMBANKMENT
PREVIOUSLY OVERTOPPED
SAY 0.5 FT ± OVER TOP OF DAM

RESERVOIR # 4

BREACH WIDTH = 50'

SIDE SLOPES (EARTH EMBANKMENT) = 1:1

FAILURE TIME (EARTH EMBANKMENT) =
BETWEEN 15 MIN. AND 2 HR.
USE: .25 HR., .5 HR., 1.0 HR., 2.0 HR.

POOL LEVEL AT FAILURE: EARTH EMBANKMENT WITH
CONCRETE CORE WALL.
USE: 1.0 FOOT OVER TOP OF DAM

LAST MODIFICATION 26 FEB 79

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  1          A1     GLEN BROOK RESERVOIR NO. 4 DAM  **** GLEN BROOK
  2          A2     BRIAR CREEK TWP., COLUMBIA COUNTY
  3          A3     NDI # PA00650   PA DER # 19-8
  4          B   300      0     15      0      0      0      0      0     -4      0
  5          B1    5
  6          J     1      9      1
  7          J1    1    .75     .5     .35     .25     .2     .15     .1    .05
  8          K              1                                    1
  9          K1                INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR
 10          M     1      1    2.7             2.8
 11          P           22.2   117.5    127   136.5   142.5    145
 12          T                                                  1    .05
 13          W   2.2     .5
 14          X  -1.5    -.05      2
 15          K     1      2                                    1
 16          K1                RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR
 17          Y                          1
 18          Y1    1                                          30.7    -1
 19          Y4  761   766.6   767.1   767.6   768.6   769.4   769.9   770.5   771.5   772.5
 20          Y5    0      55      98     171     378     590     900    1461    2685    4189
 21          $A    0     2.9     9.2
 22          $E 729.3     761     780
 23          $$ 766.6
 24          $D 769.4
 25          K              3                                    1
 26          K1                INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 RESER
 27          M     1      1     .1             2.8
 28          P           22.2   117.5    127   136.5   142.5    145
 29          T                                                  1    .05
 30          W   1.0     .5
 31          X  -1.5    -.05      2
 32          K     2      4                                    1
 33          K1                COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR
 34          K     1      5                                    1
 35          K1                RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR
 36          Y                          1      0
 37          Y1    1                                          194.5    -1
 38          Y4758.10   758.2   758.7   759.2   760.2   761.4   762.1   762.9   763.9   764.9
 39          Y5    0      58      92     154     331     610     809    1492    2970    5040
 40          $A    0     7.7    13.8
 41          $E 682.5   758.2     780
 42          $$ 758.2
 43          $D 761.4
 44          K     99
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1                 PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                      RUNOFF HYDROGRAPH AT          1
                      ROUTE HYDROGRAPH TO           2
                      RUNOFF HYDROGRAPH AT          3
                      COMBINE  2 HYDROGRAPHS AT     4
                      ROUTE HYDROGRAPH TO           5
                      END OF NETWORK
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1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
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GLEN BROOK RESERVOIR NO. 4 DAM **** GLEN BROOK
BRIAR CREEK TWP,, COLUMBIA COUNTY
NDI # PA00650 PA DER # 19-8

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .75 .50 .35 .25 .20 .15 .10 .05

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.70	0.00	2.80	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.20 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG= 2.22 HOURS, CP= .50 VOL= 1.00

14.	51.	104.	166.	233.	298.	349.	384.	401.	392.
364.	335.	309.	284.	261.	241.	221.	204.	188.	173.
159.	146.	135.	124.	114.	105.	97.	89.	82.	75.
69.	64.	59.	54.	50.	46.	42.	39.	36.	33.
30.	28.	26.	24.	22.	20.	18.	17.	16.	14.
13.	12.	11.	10.	9.	9.	8.	7.	7.	6.
6.	5.	5.	4.	4.	4.	3.	3.	3.	

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM	25.75	23.16	2.59	161872.	
	(654.)(	588.)(	66.)(	4583.70)	

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	31.	-1

STAGE	761.00	766.60	767.10	767.60	768.60	769.40	769.90	770.50	771.50	772.5
FLOW	0.00	55.00	98.00	171.00	378.00	590.00	900.00	1461.00	2685.00	4187.0

SURFACE AREA=	0.	3.	9.
CAPACITY=	0.	31.	140.
ELEVATION=	729.	761.	780.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
766.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
769.4	0.0	0.0	0.

PEAK OUTFLOW IS 5798. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 4348. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 2899. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 2029. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 1449. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 1159. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 868. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 574. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 286. AT TIME 42.25 HOURS

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OT
4/1

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 RESER

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.10	0.00	2.80	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.00 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= 1.00 HOURS, CP= .50 VOL= 1.00

3.	12.	23.	31.	32.	27.	23.	19.	15.	13.
10.	9.	7.	6.	5.	4.	3.	3.	2.	2.
1.	1.	1.	1.	1.	1.	0.	0.	0.	0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.75	23.16	2.59	6068.
										(654.)(	588.)(	66.)(	171.83)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IPRT	IPMP	LSTR

OT
5/7

HYDROGRAPH ROUTING

RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	195.	-1

STAGE	758.10	758.20	758.70	759.20	760.20	761.40	762.10	762.90	763.90	764.9
FLOW	0.00	58.00	92.00	154.00	331.00	610.00	809.00	1492.00	2970.00	5040.0
SURFACE AREA=	0.	8.	14.							
CAPACITY=	0.	194.	425.							
ELEVATION=	683.	758.	780.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
758.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
761.4	0.0	0.0	0.

PEAK OUTFLOW IS 6032. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 4525. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 3018. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 2110. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 1505. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 1201. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 899. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 580. AT TIME 42.50 HOURS

OUTFLOW IS 281. AT TIME 43.00 HOURS

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01

6/7

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .75	RATIO 3 .50	RATIO 4 .35	RATIO 5 .25	RATIO 6 .20	RATIO 7 .15	RATIO 8 .10	RATIO 9 .05
HYDROGRAPH AT	1	2.70	1	5793.	4344.	2896.	2027.	1448.	1159.	869.	579.	290.
	(	6.99)	(	164.03)(	123.02)(	82.01)(	57.41)(	41.01)(	32.81)(	24.60)(	16.40)(	8.20)
ROUTED TO	2	2.70	1	5798.	4348.	2899.	2029.	1449.	1159.	868.	574.	286.
	(	6.99)	(	164.18)(	123.13)(	82.09)(	57.46)(	41.02)(	32.83)(	24.57)(	16.25)(	8.10)
HYDROGRAPH AT	3	.10	1	332.	249.	166.	116.	83.	66.	50.	33.	17.
	(	.26)	(	9.39)(	7.04)(	4.69)(	3.29)(	2.35)(	1.88)(	1.41)(	.94)(	.47)
2 COMBINED	4	2.80	1	6031.	4523.	3015.	2111.	1507.	1206.	903.	596.	297.
	(	7.25)	(	170.77)(	128.08)(	85.39)(	59.77)(	42.67)(	34.15)(	25.56)(	16.86)(	8.40)
ROUTED TO	5	2.80	1	6032.	4525.	3018.	2110.	1505.	1201.	899.	580.	281.
	(	7.25)	(	170.82)(	128.12)(	85.47)(	59.75)(	42.61)(	34.01)(	25.45)(	16.43)(	7.95)

SUMMARY OF DAM SAFETY ANALYSIS

GLEN BROOK #2

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.01	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	773.57	4.17	89.	5798.	13.25	42.00	0.00
.75	772.61	3.21	83.	4348.	11.75	42.00	0.00
.50	771.64	2.24	77.	2899.	10.00	42.00	0.00
.35	770.96	1.56	73.	2029.	8.25	42.00	0.00
.25	770.49	1.09	70.	1449.	6.25	42.00	0.00
.20	770.18	.78	69.	1159.	5.00	42.00	0.00
.15	769.85	.45	67.	868.	3.75	42.00	0.00
.10	769.34	0.00	64.	574.	0.00	42.25	0.00
.05	768.16	0.00	58.	286.	0.00	42.25	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.22	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	59.	58.	610.

RATIO OF	MAXIMUM RESERVOIR	MAXIMUM DEPTH	MAXIMUM STORAGE	MAXIMUM OUTFLOW	DURATION OVER TOP	TIME OF MAX OUTFLOW	TIME OF FAILURE

GLEN BROOK #4

OT
7/7

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.22	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	59.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	765.38	3.98	256.	6032.	13.25	42.00	0.00
.75	764.65	3.25	249.	4525.	12.00	42.00	0.00
.50	763.92	2.52	242.	3018.	10.00	42.00	0.00
.35	763.32	1.92	237.	2110.	8.25	42.00	0.00
.25	762.91	1.51	233.	1505.	6.25	42.00	0.00
.20	762.56	1.16	230.	1201.	5.25	42.00	0.00
.15	762.21	.81	227.	899.	3.75	42.00	0.00
.10	761.27	0.00	219.	580.	0.00	42.50	0.00
.05	759.92	0.00	208.	281.	0.00	43.00	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.
N>

FB 1/7

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**********
    1        A1      GLEN BROOK RESERVOIR NO. 4 DAM ****  GLEN BROOK
    2        A2      BRIAR CREEK TWP., COLUMBIA COUNTY
    3        A3      NDI # PA00650   PA DER # 19-8
    4        B   300      0     15      0      0      0      0      0     -4      0
    5        B1    5
    6        J     1      1      1
    7        J1  .18
    8        K              1                                        1
    9        K1               INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR
   10        M     1        1    2.7            2.8                                    1
   11        P            22.2  117.5    127  136.5  142.5    145
   12        T                                                   1    .05
   13        W   2.2      .5
   14        X  -1.5     -.05      2
   15        K     1        2                                        1
   16        K1               RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR
   17        Y                                 1      1
   18        Y1    1                                                30.7    -1
   19        Y4  761   766.6  767.1  767.6  768.6  769.4  769.9  770.5  771.5  772.5
   20        Y5    0      55     98    171    378    590    900   1461   2685   4189
   21        $A    0     2.9    9.2
   22        $E 729.3    761    780
   23        $$ 766.6
   24        $D 769.4
   25        K              3                                        1
   26        K1               INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 RESER
   27        M     1        1     .1            2.8                                    1
   28        P            22.2  117.5    127  136.5  142.5    145
   29        T                                                   1    .05
   30        W   1.0      .5
   31        X  -1.5     -.05      2
   32        K     2        4                                        1
   33        K1               COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR
   34        K     1        5                                        1
   35        K1               RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR
   36        Y                                 1      1
   37        Y1    1                                                194.5    -1
   38        Y4758.10  758.2  758.7  759.2  760.2  761.4  762.1  762.9  763.9  764.9
   39        Y5    0      58     92    154    331    610    809   1492   2970   5040
   40        $A    0     7.7   13.8
   41        $E 682.5  758.2    780
   42        $$ 758.2
   43        $D 761.4
   44        K     1        6                                        1
   45        K1               REACH 5 - 6
   46        Y                                 1      1
   47        Y1    1
   48        Y6   .1     .05      .1    654    700   2750  .01053
   49        Y7    0      700     100    680    375    660    410    654    425    654
   50        Y7  750      660     775    680    800    700
  1 51       K    99
  1                  PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                RUNOFF HYDROGRAPH AT          1
                                ROUTE HYDROGRAPH TO           2
                                RUNOFF HYDROGRAPH AT          3
                                COMBINE  2 HYDROGRAPHS AT     4
                                ROUTE HYDROGRAPH TO           5
                                ROUTE HYDROGRAPH TO           6
                                END OF NETWORK
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GLEN BROOK RESERVOIR NO. 4 DAM **** GLEN BROOK
BRIAR CREEK TWP., COLUMBIA COUNTY
NDI # PA00650 PA DER # 19-8

PB 2/7

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= .18

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.70	0.00	2.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.20 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG= 2.22 HOURS, CP= .50 VOL= 1.00

14.	51.	104.	166.	233.	298.	349.	384.	401.	392.
364.	335.	309.	284.	261.	241.	221.	204.	188.	173.
159.	146.	135.	124.	114.	105.	97.	89.	82.	75.
69.	64.	59.	54.	50.	46.	42.	39.	36.	33.
30.	28.	26.	24.	22.	20.	18.	17.	16.	14.
13.	12.	11.	10.	9.	9.	8.	7.	7.	6.
6.	5.	5.	4.	4.	4.	3.	3.	3.	

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM	25.75	23.16	2.59	161872.
	(654.)	(588.)	(66.)	(4583.70)

PB 3/7

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	31.	-1

STAGE	761.00	766.60	767.10	767.60	768.60	769.40	769.90	770.50	771.50	772.50
FLOW	0.00	55.00	98.00	171.00	378.00	590.00	900.00	1461.00	2685.00	4189.00

SURFACE AREA=	0.	3.	9.
CAPACITY=	0.	31.	140.
ELEVATION=	729.	761.	780.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
766.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
769.4	0.0	0.0	0.

PEAK OUTFLOW IS 1043. AT TIME 42.00 HOURS

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 RESER

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.10	0.00	2.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.00 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

PB 4/7

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= 1.00 HOURS, CP= .50 VOL= 1.00

3.	12.	23.	31.	32.	27.	23.	19.	15.	13.
10.	9.	7.	6.	5.	4.	3.	3.	2.	2.
1.	1.	1.	1.	1.	1.	0.	0.	0.	0.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	23.75	23.16	2.59	6068.
										(654.)(	588.)(	66.)(	171.83)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	195.	-1

STAGE	758.10	758.20	758.70	759.20	760.20	761.40	762.10	762.90	763.90	764.9
FLOW	0.00	58.00	92.00	154.00	331.00	610.00	809.00	1492.00	2970.00	5040.0
SURFACE AREA=	0.	8.	14.							
CAPACITY=	0.	194.	425.							
ELEVATION=	683.	758.	780.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
758.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
761.4	0.0	0.0	0.

PB 5/7

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 5 - 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0500	.1000	654.0	700.0	2750.	.01053

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 700.00 100.00 680.00 375.00 660.00 410.00 654.00 425.00 654.00
750.00 660.00 775.00 680.00 800.00 700.00

STORAGE	0.00	13.39	48.99	104.52	167.51	236.05	310.14	389.78	474.97	565.71
	662.00	763.73	868.66	975.91	1085.46	1197.33	1311.51	1428.00	1546.81	1667.93
OUTFLOW	0.00	781.45	4413.12	13461.67	28219.60	47372.72	70710.30	98117.77	129533.09	164926.36
	204288.83	247881.76	296098.65	348099.15	403808.34	463166.36	526124.88	592644.52	662693.13	736244.46
STAGE	654.00	656.42	658.84	661.26	663.68	666.11	668.53	670.95	673.37	675.79
	678.21	680.63	683.05	685.47	687.89	690.32	692.74	695.16	697.58	700.00
FLOW	0.00	781.45	4413.12	13461.67	28219.60	47372.72	70710.30	98117.77	129533.09	164926.36
	204288.83	247881.76	296098.65	348099.15	403808.34	463166.36	526124.88	592644.52	662693.13	736244.46

MAXIMUM STAGE IS 656.6

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION STATION AREA PLAN RATIO 1

1 ********** ********** ********** ********** **********

PB 6/7

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .18
HYDROGRAPH AT	1	2.70	1	1043.
	(	6.99)	(	29.52)(
ROUTED TO	2	2.70	1	1043.
	(	6.99)	(	29.55)(
HYDROGRAPH AT	3	.10	1	60.
	(	.26)	(	1.69)(
2 COMBINED	4	2.80	1	1085.
	(	7.25)	(	30.73)(
ROUTED TO	5	2.80	1	1081.
	(	7.25)	(	30.62)(
ROUTED TO	6	2.80	1	1080.
	(	7.25)	(	30.58)(

1 SUMMARY OF DAM SAFETY ANALYSIS

#2

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.01	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	770.05	.65	68.	1043.	4.50	42.00	0.00

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.22	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	59.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	762.42	1.02	229.	1081.	4.50	42.00	0.00

	OF PMF	RESERVOIR W.S.ELEV	DEPTH OVER DAM	STORAGE AC-FT	OUTFLOW CFS	OVER TOP HOURS	MAX OUTFLOW HOURS	FAILURE HOURS
	.18	770.05	.65	68.	1043.	4.50	42.00	0.00

1 SUMMARY OF DAM SAFETY ANALYSIS

#4

PB 7/7

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.22	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	59.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	762.42	1.02	229.	1081.	4.50	42.00	0.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.18	1080.	656.6	42.25

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.
N>

B 1/10

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**********
    1        A1      GLEN BROOK RESERVOIR NO. 4 DAM  ****  GLEN BROOK
    2        A2      BRIAR CREEK TWP., COLUMBIA COUNTY
    3        A3      NDI # PA00650   PA DER # 19-8
    4        B   300      0     15      0      0      0      0      0     -4      0
    5        B1    5
    6        J     4      1      1
    7        J1  .18
    8        K              1                                    1
    9        K1                INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR
   10        M     1        1    2.7             2.8                                    1
   11        P            22.2  117.5    127   136.5  142.5     145
   12        T                                                  1    .05
   13        W   2.2      .5
   14        X  -1.5    -.05      2
   15        K     1      2                                    1
   16        K1               RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR
   17        Y                                1      1
   18        Y1    1                                          30.7     -1
   19        Y4  761   766.6  767.1   767.6  768.6  769.4   769.9  770.5  771.5  772.5
   20        Y5    0      55     98     171    378    590     900   1461   2685   4189
   21        $A    0     2.9    9.2
   22        $E 729.3    761    780
   23        $$ 766.6
   24        $D 769.4
   25        $B   50      1    742    .25    761    770
   26        $B   50      1    742     .5    761    770
   27        $B   50      1    742      1    761    770
   28        $B   50      1    742      2    761    770
   29        K              3                                    1
   30        K1               INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 POND
   31        M     1        1     .1             2.8                                    1
   32        P            22.2  117.5    127   136.5  142.5     145
   33        T                                                  1    .05
   34        W   1.0      .5
   35        X  -1.5    -.05      2
   36        K     2      4                                    1
   37        K1               COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR
   38        K     1      5                                    1
   39        K1               RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR
   40        Y                                1      1
   41        Y1    1                                         194.5     -1
   42        Y4758.10   758.2  758.7   759.2  760.2  761.4   762.1  762.9  763.9  764.9
   43        Y5    0      58     92     154    331    610     809   1492   2970   5040
   44        $A    0     7.7   13.8
   45        $E 682.5    758.2  780
   46        $$ 758.2
   47        $D 761.4
   48        $B   50      1    718    .25   758.2  762.4
   49        $B   50      1    718     .5   758.2  762.4
   50        $B   50      1    718      1   758.2  762.4
1  51        $B   50      1    718      2   758.2  762.4
   52        K     1      6                                    1
   53        K1               REACH 5 - 6
   54        Y                                1      1
   55        Y1    1
   56        Y6   .1     .05     .1    654    700   2750  .01053
   57        Y7    0     700    100    680    375    660     410    654    425    654
   58        Y7  750     660    775    680    800    700
   59        K    99
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1 PREVIEW OF REQUIRED OF STREAM HYDROLOGY PARAMETERS

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

B 2/10

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
RUNOFF HYDROGRAPH AT	3
COMBINE 2 HYDROGRAPHS AT	4
ROUTE HYDROGRAPH TO	5
ROUTE HYDROGRAPH TO	6
END OF NETWORK	

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE* 79/07/11.
TIME* 17.02.37.

GLEN BROOK RESERVOIR NO. 4 DAM **** GLEN BROOK
BRIAR CREEK TWP., COLUMBIA COUNTY
NDI # PA00650 PA DER # 19-8

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 4 NRTIO= 1 LRTIO= 1

RTIOS= .18

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUB AREA TO GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.70	0.00	2.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

UNIT HYDROGRAPH DATA

TP= 2.20 CP= .50 NTA= 0

B 3/10

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG= 2.22 HOURS, CP= .50 VOL= 1.00

14.	51.	104.	166.	233.	298.	349.	384.	401.	392.
364.	335.	309.	284.	261.	241.	221.	204.	188.	173.
159.	146.	135.	124.	114.	105.	97.	89.	82.	75.
69.	64.	59.	54.	50.	46.	42.	39.	36.	33.
30.	28.	26.	24.	22.	20.	18.	17.	16.	14.
13.	12.	11.	10.	9.	9.	8.	7.	7.	6.
6.	5.	5.	4.	4.	4.	3.	3.	3.	

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 25.75 23.16 2.59 161872.
(654.)(588.)(66.)(4583.70)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING - THRU GLEN BROOK NO. 2 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	31.	-1

STAGE	761.00	766.60	767.10	767.60	768.60	769.40	769.90	770.50	771.50	772.50
FLOW	0.00	55.00	98.00	171.00	378.00	590.00	900.00	1461.00	2685.00	4189.00
SURFACE AREA=	0.	3.	9.							
CAPACITY=	0.	31.	140.							
ELEVATION=	729.	761.	780.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
766.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
769.4	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	742.00	.25	761.00	770.00

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 5463. AT TIME 41.65 HOURS

B 4/10

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	742.00	.50	761.00	770.00

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 3426. AT TIME 41.73 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	742.00	1.00	761.00	770.00

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 2303. AT TIME 41.88 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	742.00	2.00	761.00	770.00

BEGIN DAM FAILURE AT 41.50 HOURS

PEAK OUTFLOW IS 1692. AT TIME 42.13 HOURS

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - SUBAREA BELOW NO. 2 RESERVOIR TO NO. 4 POND

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.10	0.00	2.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.00 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

3.	12.	23.	31.	32.	27.	23.	19.	15.	13.
10.	9.	7.	6.	5.	4.	3.	3.	2.	2.
1.	1.	1.	1.	1.	1.	0.	0.	0.	0.

B 5/10

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.75	23.16	2.59	6068.
										(654.)(	588.)(	66.)(	171.83)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS AT GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING - GLEN BROOK NO. 4 RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	195.	-1

STAGE	758.10	758.20	758.70	759.20	760.20	761.40	762.10	762.90	763.90	764.90
FLOW	0.00	58.00	92.00	154.00	331.00	610.00	809.00	1492.00	2970.00	5040.00
SURFACE AREA=	0.	8.	14.							
CAPACITY=	0.	194.	425.							
ELEVATION=	683.	758.	780.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
758.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
761.4	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL

BEGIN DAM FAILURE AT 41.75 HOURS

PEAK OUTFLOW IS 14736. AT TIME 41.92 HOURS

B 6/10

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	718.00	.50	758.20	762.40

BEGIN DAM FAILURE AT 41.75 HOURS

PEAK OUTFLOW IS 8945. AT TIME 41.99 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	718.00	1.00	758.20	762.40

BEGIN DAM FAILURE AT 41.75 HOURS

PEAK OUTFLOW IS 5570. AT TIME 42.15 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	718.00	2.00	758.20	762.40

BEGIN DAM FAILURE AT 41.75 HOURS

PEAK OUTFLOW IS 3486. AT TIME 42.38 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 5 - 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0500	.1000	654.0	700.0	2750.	.01053

B 7/10

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 700.00 100.00 680.00 375.00 660.00 410.00 654.00 425.00 654.00
750.00 660.00 775.00 680.00 800.00 700.00

STORAGE	0.00	13.39	48.99	104.52	167.51	236.03	310.14	389.78	474.97	565.71
	662.00	763.73	868.66	975.91	1085.46	1197.33	1311.51	1428.00	1546.81	1667.93
OUTFLOW	0.00	781.45	4413.12	13461.67	28219.60	47372.72	70710.30	98117.77	129533.09	164926.36
	204288.83	247881.76	296098.65	348099.15	403808.34	463166.36	526124.88	592644.52	662693.13	736244.46
STAGE	654.00	656.42	658.84	661.26	663.68	666.11	668.53	670.95	673.37	675.79
	678.21	680.63	683.05	685.47	687.89	690.32	692.74	695.16	697.58	700.00
FLOW	0.00	781.45	4413.12	13461.67	28219.60	47372.72	70710.30	98117.77	129533.09	164926.36
	204288.83	247881.76	296098.65	348099.15	403808.34	463166.36	526124.88	592644.52	662693.13	736244.46

MAXIMUM STAGE IS 659.6

MAXIMUM STAGE IS 659.5

MAXIMUM STAGE IS 659.1

MAXIMUM STAGE IS 658.1

********** ********** ********** ********** **********

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1
				.18
HYDROGRAPH AT	1	2.70	1	1043.
	(	6.99)	(	29.52)(
			2	1043.
			(	29.52)(
			3	1043.
			(	29.52)(
			4	1043.
			(	29.52)(
ROUTED TO	2	2.70	1	3101.
	(	6.99)	(	87.82)(
			2	3404.
			(	96.38)(
			3	2130.
			(	60.31)(
			4	1654.
			(	46.82)(
HYDROGRAPH AT	3	.10	1	60.

HYDROGRAPH AT	3	.10	1	60.
	(	.26)	(	1.69)(
			2	60.
			(	1.69)(
			3	60.
			(	1.69)(
			4	60.
			(	1.69)(
2 COMBINED	4	2.80	1	3147.
	(	7.25)	(	89.10)(
			2	3449.
			(	97.66)(
			3	2172.
			(	61.50)(
			4	1692.
			(	47.92)(
ROUTED TO	5	2.80	1	10838.
	(	7.25)	(	306.89)(
			2	8937.
			(	253.07)(
			3	5239.
			(	148.36)(
			4	3389.
			(	95.96)(
ROUTED TO	6	2.80	1	7212.
	(	7.25)	(	204.23)(
			2	6930.
			(	196.25)(
			3	5308.
			(	150.31)(
			4	3369.
			(	95.40)(

B 8/10

1

SUMMARY OF DAM SAFETY ANALYSIS

#2

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.00	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	770.01	.61	68.	5463.	1.30	41.65	41.50

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.00	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	770.01	.61	68.	3426.	1.32	41.73	41.50

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.00	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	770.01	.61	68.	2303.	1.35	41.88	41.50

PLAN 4 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	761.00	766.60	769.40
STORAGE	31.	51.	64.
OUTFLOW	0.	55.	590.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	770.01	.61	68.	1692.	1.42	42.13	41.50

1 SUMMARY OF DAM SAFETY ANALYSIS

#4

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.20	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	58.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	763.38	1.98	237.	14736.	1.32	41.92	41.75

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.20	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	58.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	763.52	2.12	239.	8945.	1.37	41.99	41.75

PLAN 3

B 10/10

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.20	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	58.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	762.99	1.59	234.	5570.	1.42	42.15	41.75

PLAN 4 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	758.20	758.20	761.40
STORAGE	194.	194.	220.
OUTFLOW	58.	58.	610.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.18	762.62	1.22	231.	3486.	1.46	42.38	41.75

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.18	7212.	659.6	42.00

PLAN 2 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.18	6930.	659.5	42.25

PLAN 3 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.18	5308.	659.1	42.25

PLAN 4 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.18	3369.	658.1	42.50

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION MAY 1978

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Trimmers Rock Formation (plus Harrell Formation on source map).

Lithology: The Trimmers Rock lithology probably dominates at the dam site. It consists of light olive gray to medium gray siltstone and silty shale, with interbedded very fine grained sandstone in the upper part. The Harrell is a gray silty shale, and probably crops out south of the dam site.

Structure

The dam is located on the south limb of the Lackawanna Syncline. The beds strike approximately N70°E and dip to NW. Details of local minor folding and faulting are not available. Fracture traces trend N15°W and N70°W.

Oberburden

This dam was built in 1909 and no exploration holes or foundation information is available. The valley of Glen Brook is quite narrow here and alluvium not more than five feet thick.

Aquifer Characteristics

The Trimmers Rock siltstones and shales are essentially impermeable rocks and the principal movement is along bedding planes and fractures.

Discussion

This dam is reported to have a concrete core wall which was placed three feet into solid rock. No leakage was reported in 1915. In 1925 it was reported that there was leakage at the toe, and on the left side of the spillway. The leakage in the spillway, which is through the embankment, has continued but the leakage at the toe apparently has not. In any case, leakage along fractures in the bedrock below the core wall is not likely to cause any deterioration of the rock.

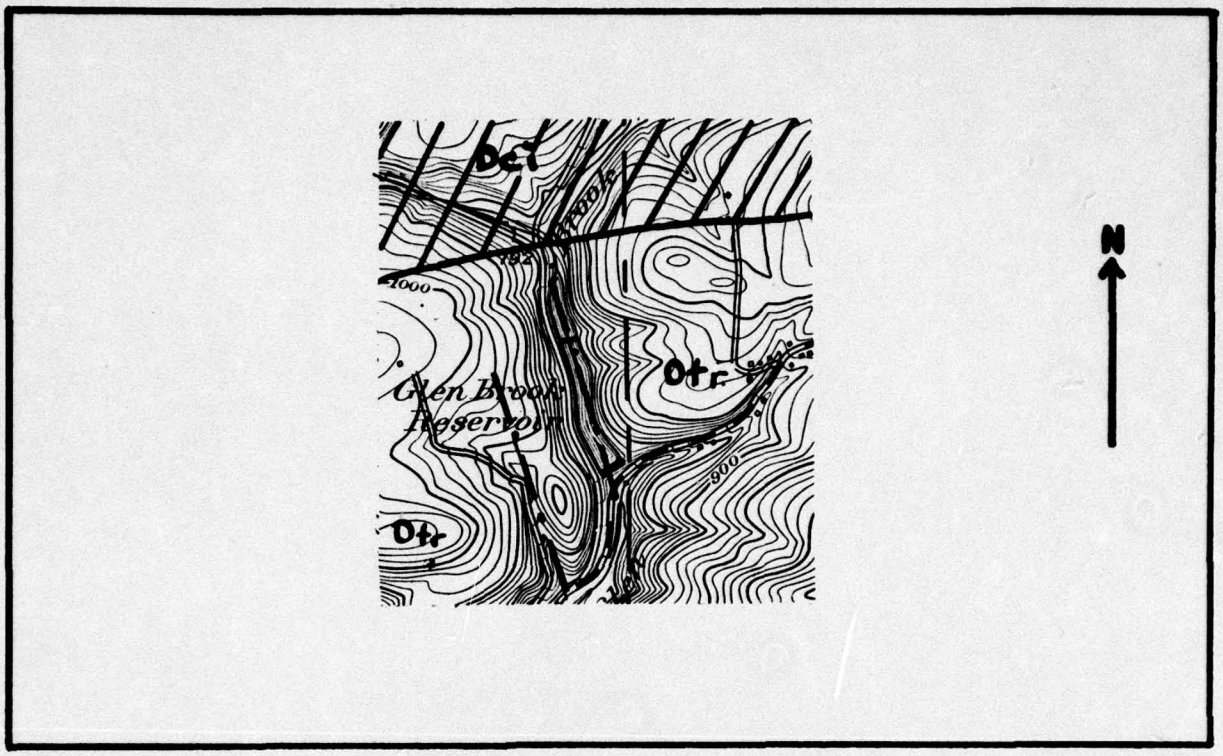
Sources of Information

1. J.D., Invers (1979). "Geologic Map of the Berwick Quadrangle, Luzerne and Columbia Counties, Pa.". Pa. Geol. Survey, Atlas 174c.

2. Inspection reports in file.

3. Air Photographs, scale 1:24,000. Dated 1969.

GEOLOGIC MAP - Glen Brook Reservoir Dam



(geology from Pa. Geol. Surv. open file)

Dcl — Catskill Fm.- Irish Valley Member

Dtr — Trimmers Rock and Harrell Fm.

—·—· air photo fracture trace

SCALE 1:24000

1 0 1 MILE

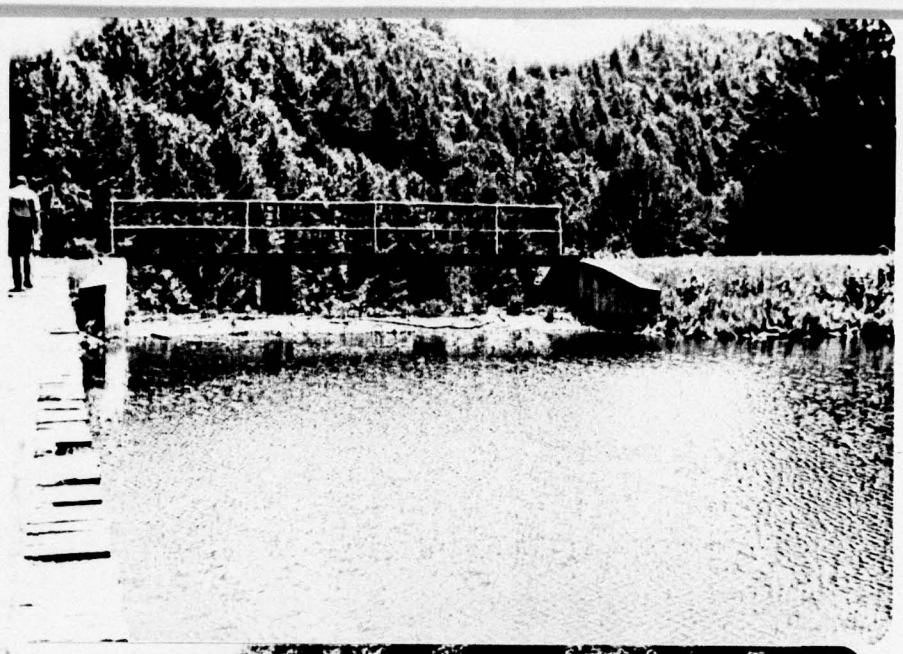
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

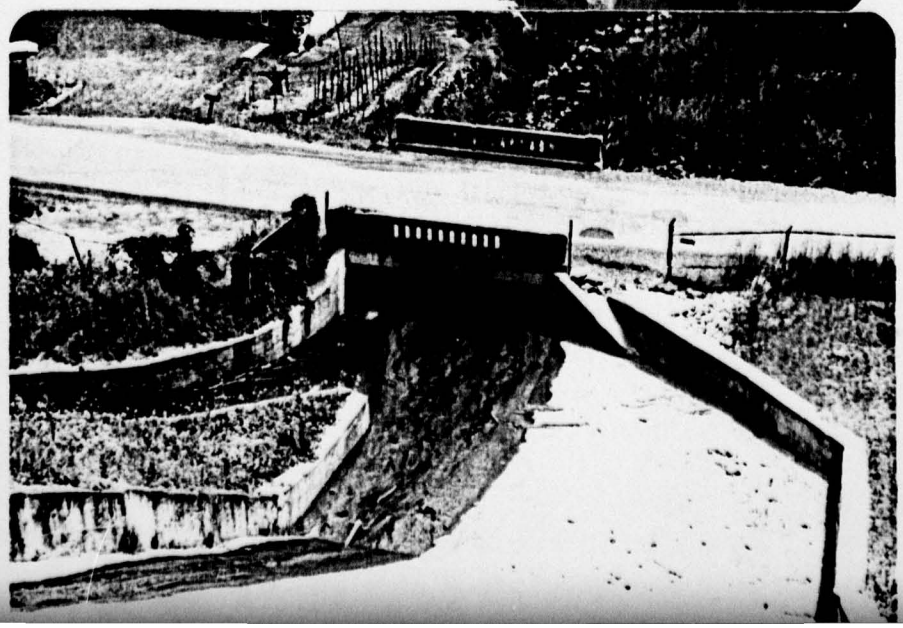
APPENDIX E

PHOTOGRAPHS



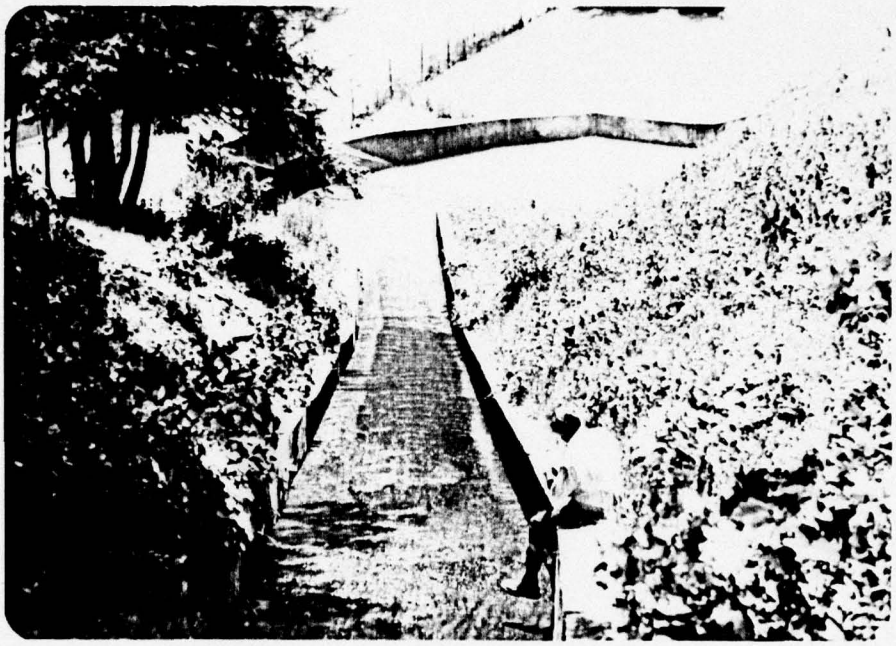
Upstream Slope
& Footbridge
Across Spillway

Footbridge to
Intake Structure



Downstream Spillway
Discharge Chute
& Highway Bridge

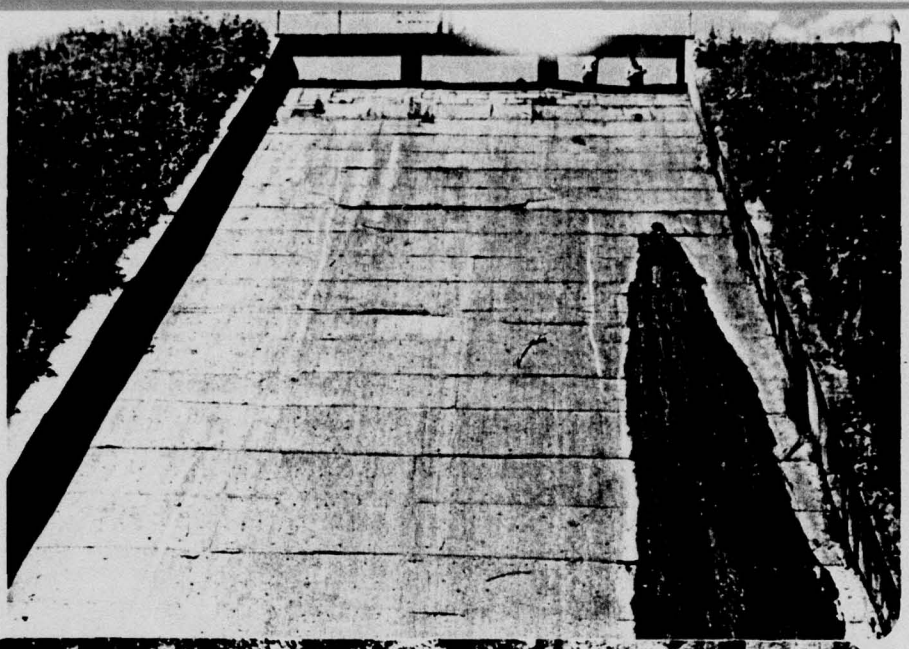
PA-650
PLATE E-I



Bypass Conduit Discharge Channel

Bypass Conduit Outlet

PA-650
PLATE E-II

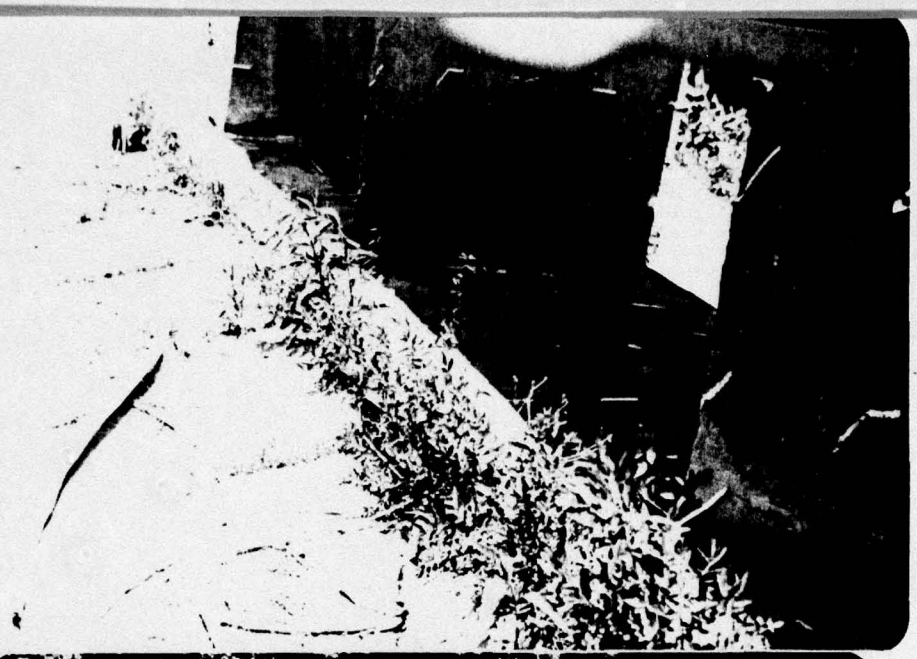


Spillway Discharge Chute

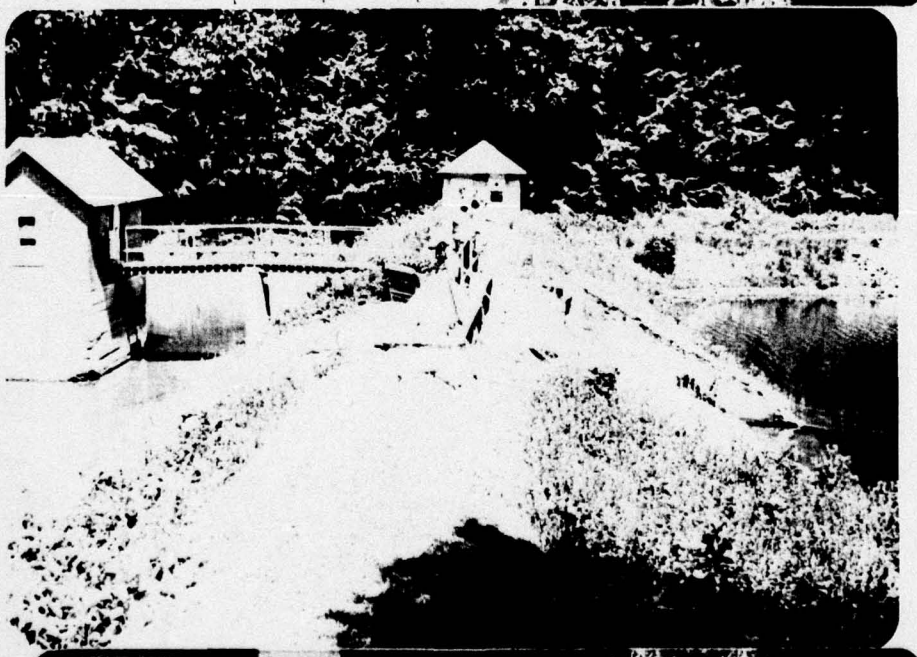
Channel Downstream from Highway Bridge

Dam No.4 Reservoir with Submerged No.1 Dam and No.2 Spillway

PA-650
PLATE E-III



Flagstone Spillway
Weir and Footbridge
Piers



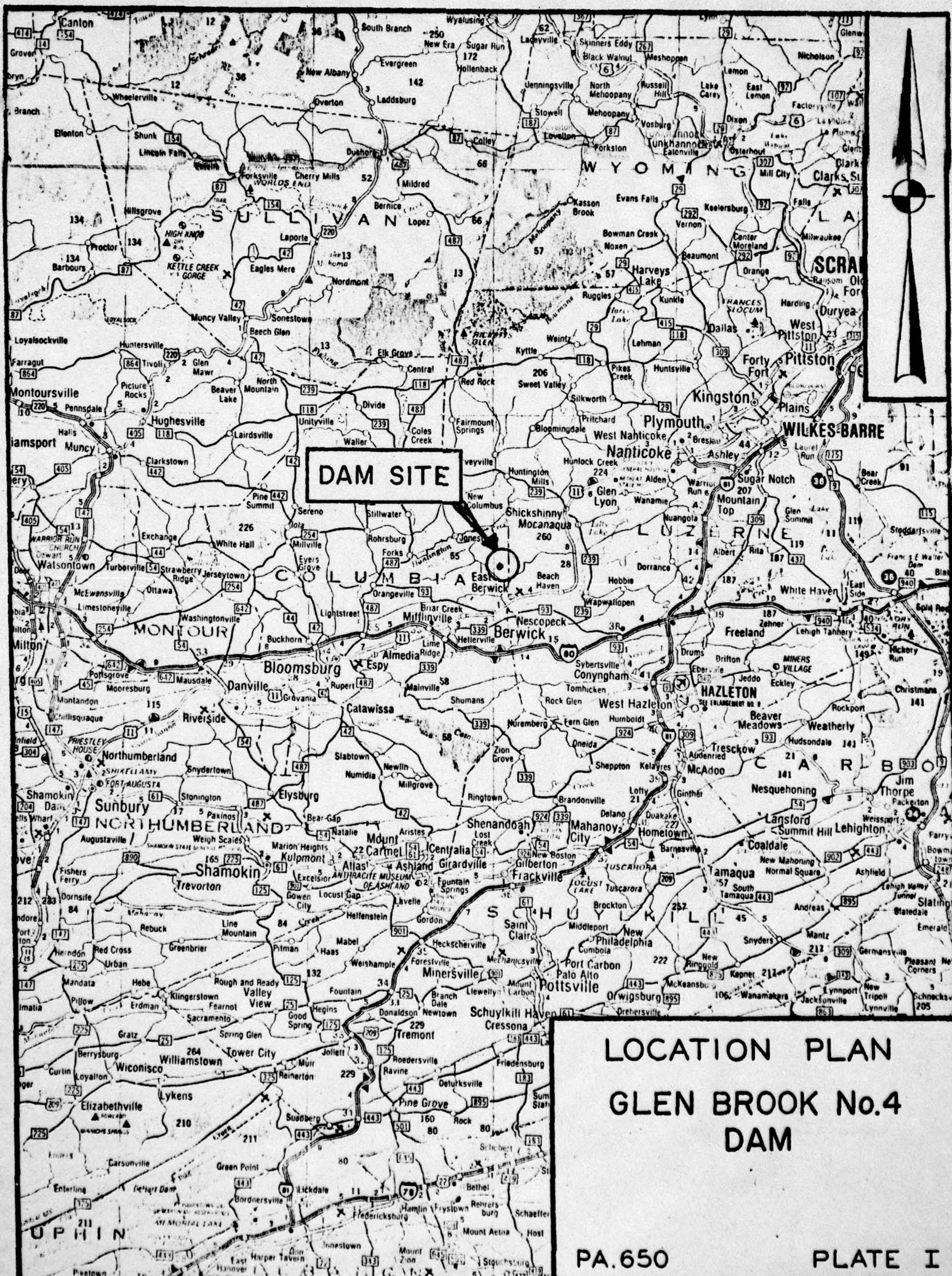
The Upstream
Glen Brook
No.2 Dam

Bypass Conduit
Gate at No.2 Dam

PA-650
PLATE E-IV

APPENDIX F

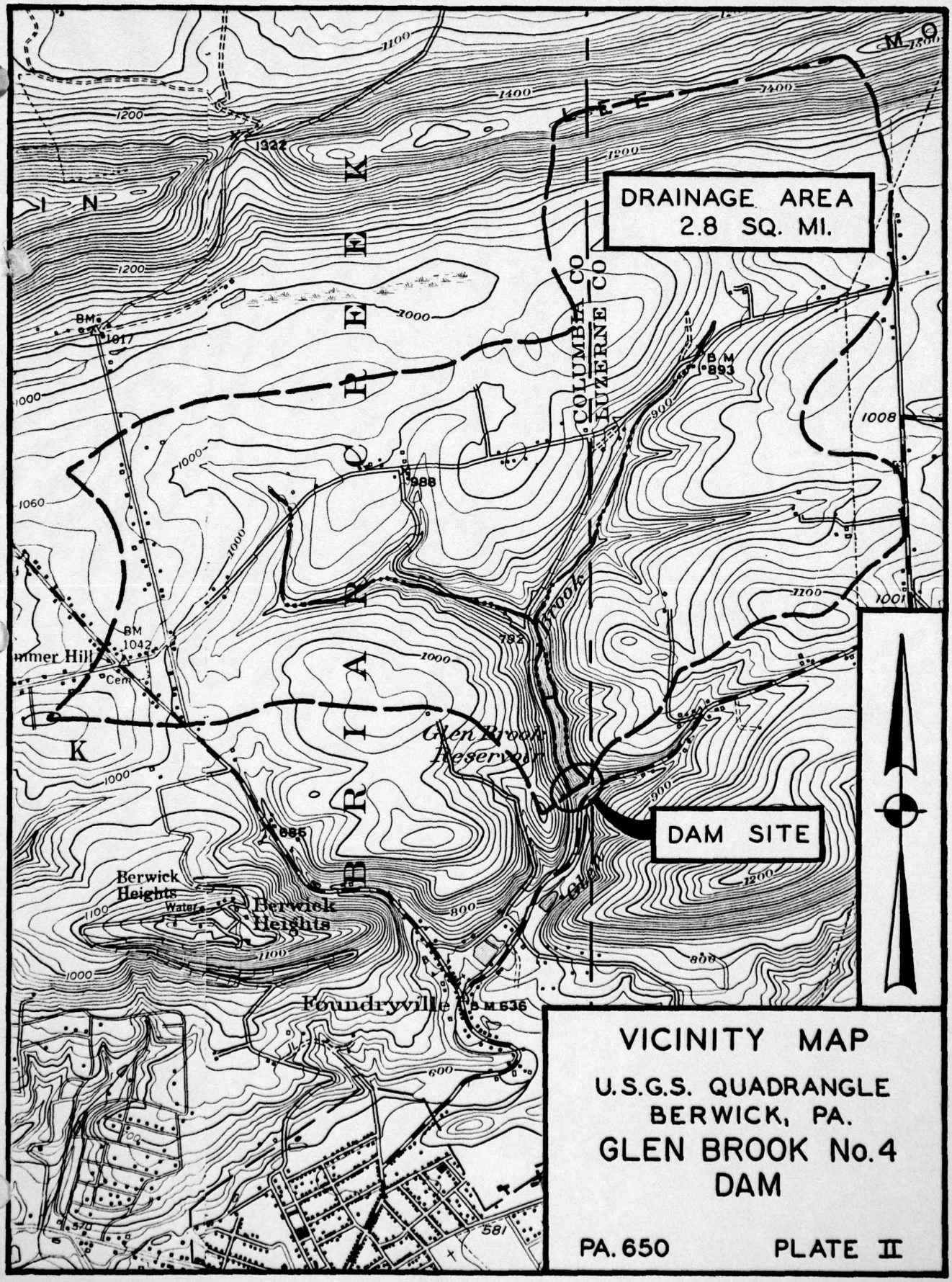
PLATES



LOCATION PLAN

GLEN BROOK No.4 DAM

PA. 650 PLATE I

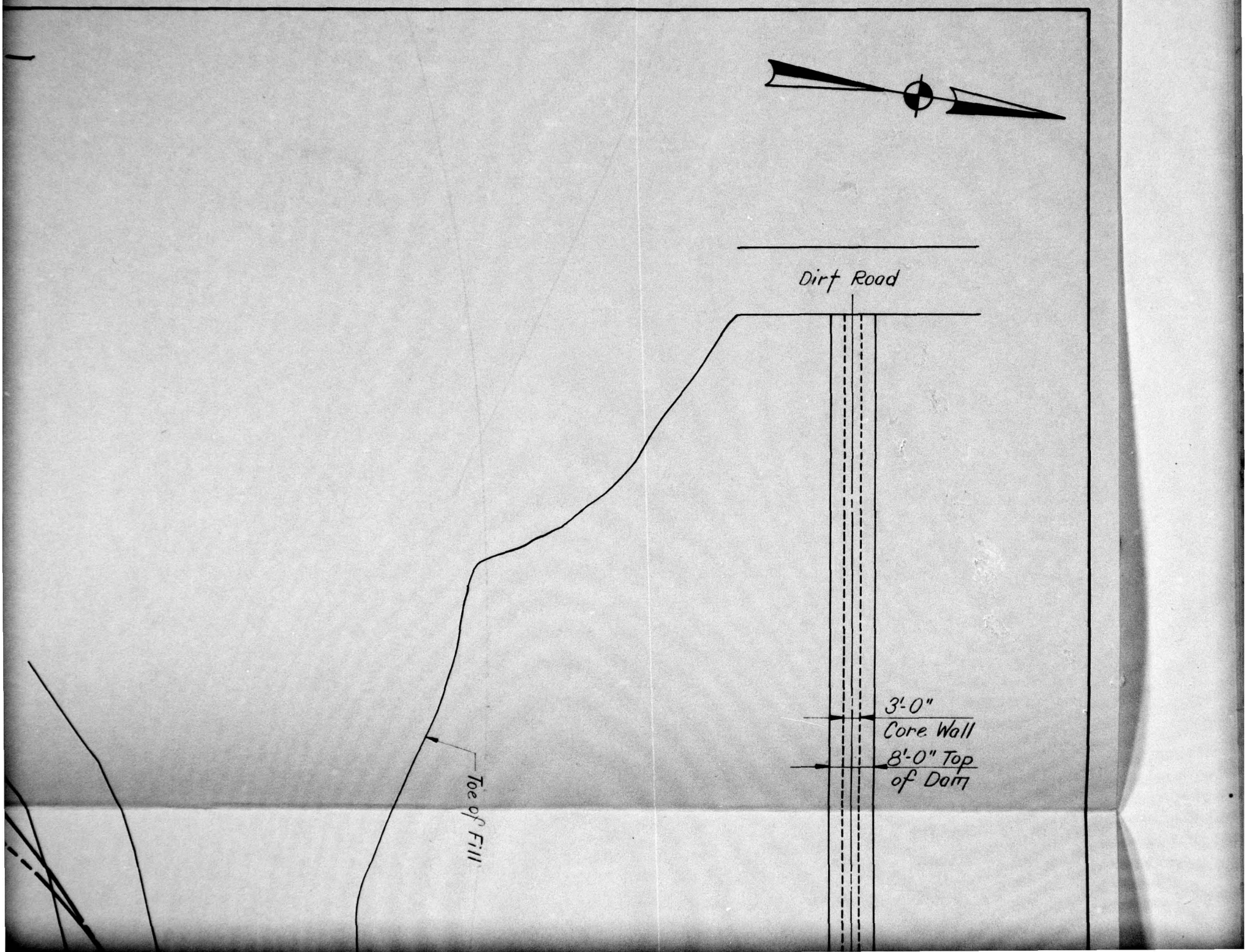


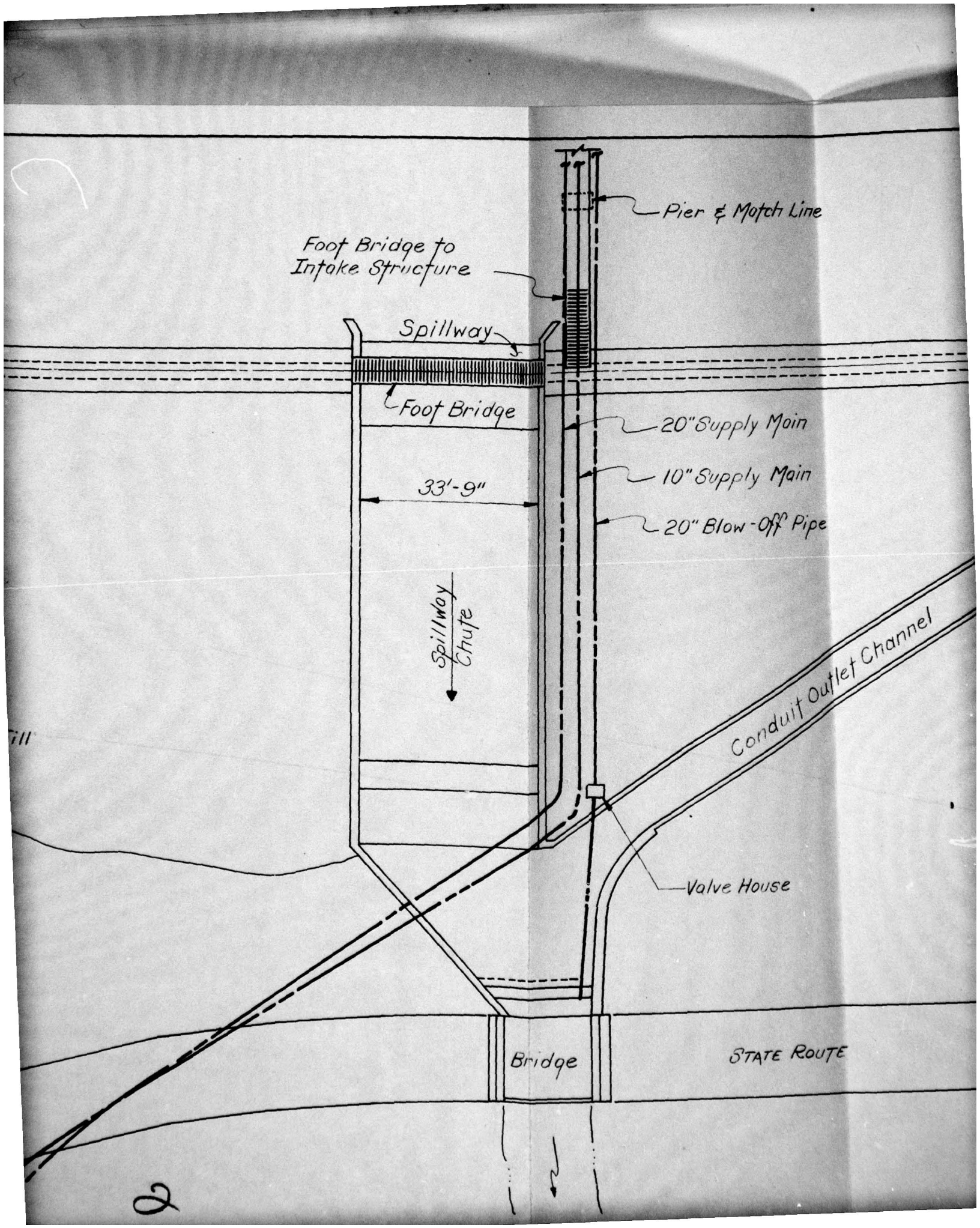
VICINITY MAP

U.S.G.S. QUADRANGLE
BERWICK, PA.

GLEN BROOK No. 4 DAM

PA. 650 PLATE II

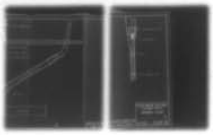

Dirt Road
3'-0"
Core Wall
8'-0" Top
of Dam
Toe of Fill


Pier & Match Line
Foot Bridge to Intake Structure
Spillway
Foot Bridge
20" Supply Main
10" Supply Main
33'-9"
20" Blow-Off Pipe
Spillway Chute
Conduit Outlet Channel
Valve House
Bridge
STATE ROUTE
2

AD-A078 872 BERGER ASSOCIATES INC HARRISBURG PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. GLEN BROOK NUMBER 4 DAM (NDI N--ETC(U)
AUG 79 DACW31-79-C--0012

UNCLASSIFIED NL

2 OF 2
ADA 078872



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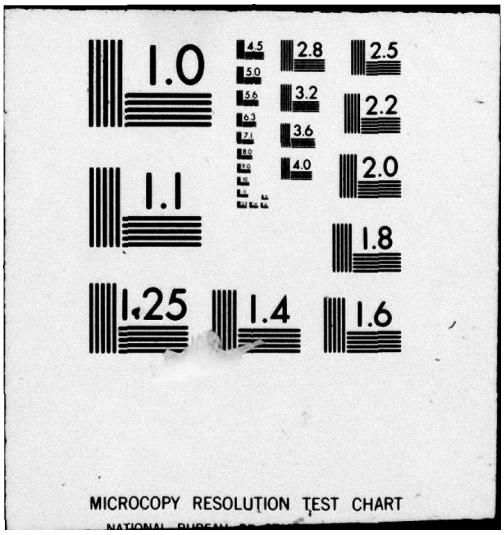
DATE FILMED
11-80
DDC


1.0
4.5
5.0
5.6
6.3
7.1
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9.0
2.8
3.2
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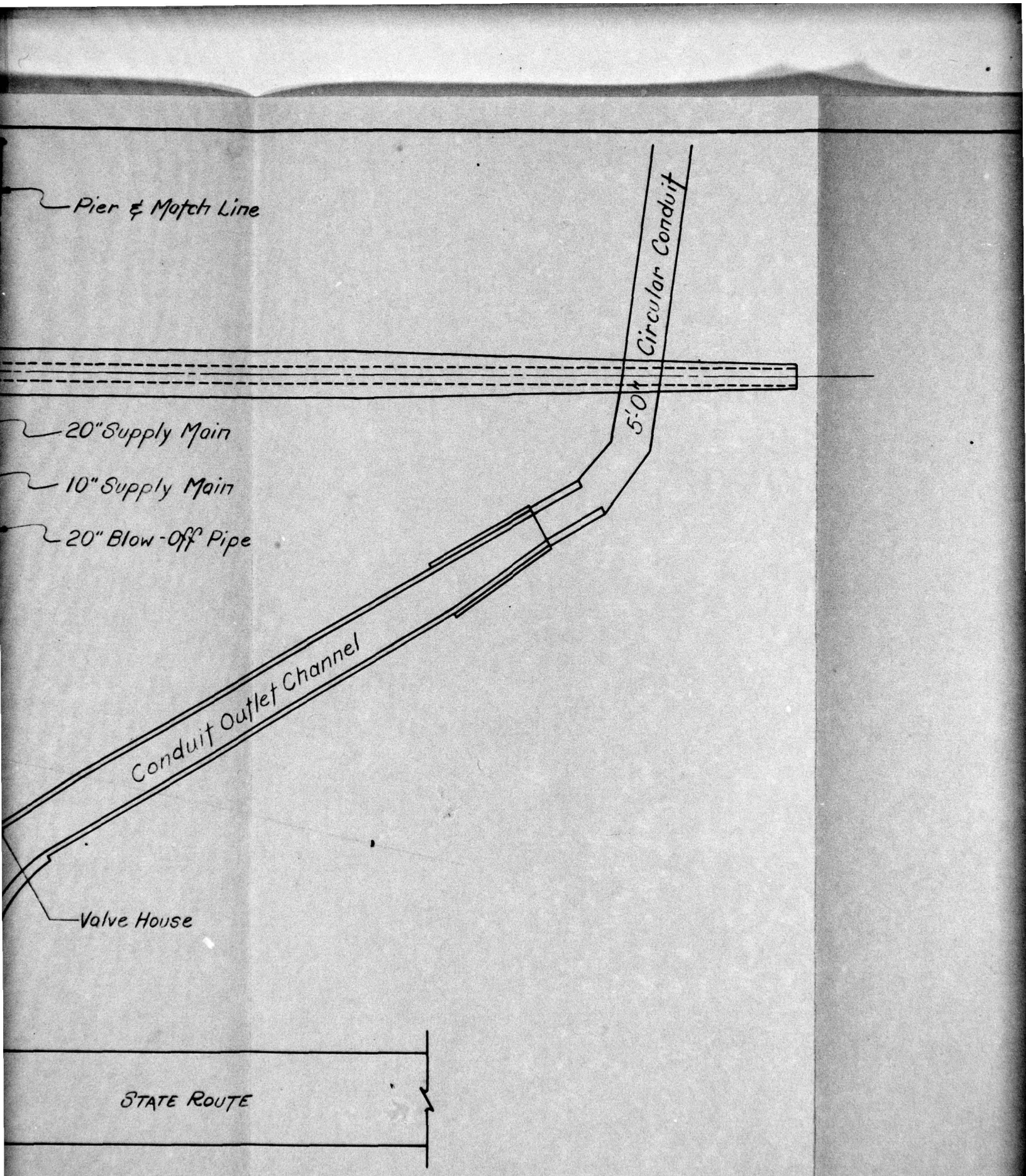
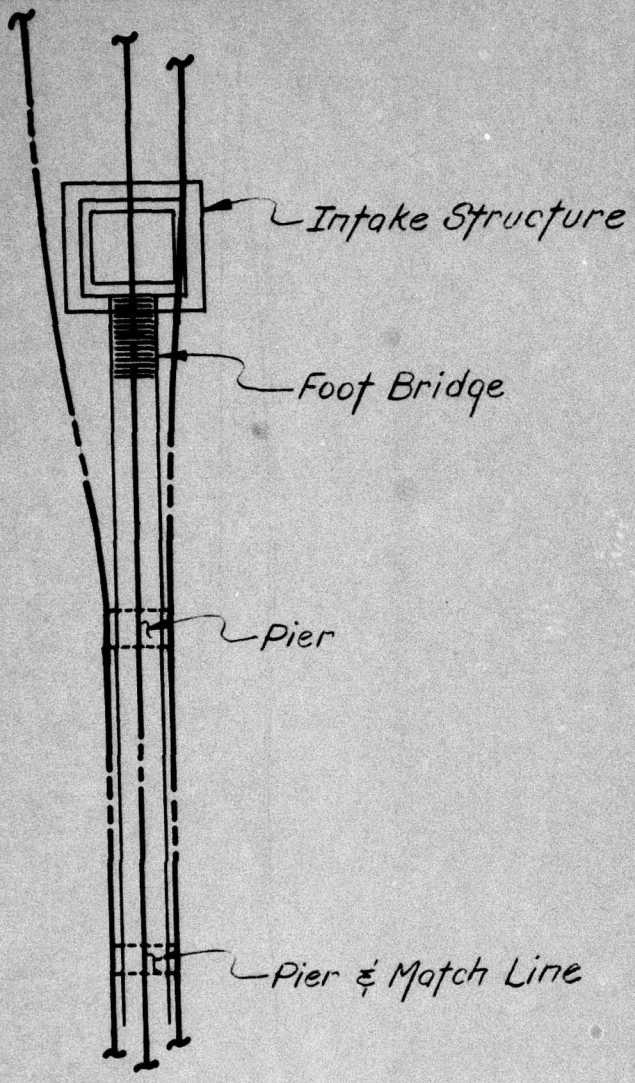
2.2
2.0
1.8
1.1
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART





GLEN BROOK No.4 DAM
COLUMBIA COUNTY
GENERAL PLAN

4

BY BERGER ASSOC. INC.
1979 SCALE: 1"=20'-0"

PA. 650 PLATE III